ADVANCING COMMERCIAL WEATHER DATA: COLLABORATIVE EFFORTS TO IMPROVE FORECASTS

HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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ADVANCING COMMERCIAL WEATHER DATA: COLLABORATIVE EFFORTS TO IMPROVE FORECASTS

WEDNESDAY, MAY 20, 2015

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:03 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Jim Bridenstine [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

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Subcommittee on Environment

Advancing Commercial Weather Data:
Collaborative Efforts to Improve Forecasts

Wednesday, May 20, 2015
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Scott Pace, Director, Space Policy Institute, George Washington University

Mr. Scott Sternberg, President, Vaisala Inc.

Ms. Nicole Robinson, Chair, Hosted Payload Alliance

Dr. Bill Gail, Chief Technology Officer, Global Weather Corporation

Dr. Thomas Bogdan, President, University Corporation for Atmospheric Research

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENVIRONMENT

HEARING CHARTER

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts

Wednesday, May 20, 2015
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

The Environment Subcommittee will hold a hearing titled *Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts* on Wednesday, May 20, 2015, at 10:00 a.m. in room 2318 of the Rayburn House Office Building. The purpose of this hearing is to examine weather data policies and acquisition strategies of the National Oceanic and Atmospheric Administration (NOAA). Robust data streams from multiple observing systems are essential to maintaining up-to-date information to predict weather accurately and with timeliness, especially for extreme weather events like tornadoes and severe storm systems. Sources available for weather data include U.S. government-, international-, and commercially-owned and operated satellite-, aviation-, and surface-based observing systems. This hearing will examine NOAA's policies and partnerships for integrating these myriad data sources into weather predictions.

Witnesses

- **Dr. Scott Pace**, Director, Space Policy Institute, George Washington University
- **Mr. Scott Sternberg**, President, Vaisala Inc.
- **Ms. Nicole Robinson,** Chair, Hosted Payload Alliance
- **Dr. Bill Gail**, Chief Technology Officer, Global Weather Corporation
- **Dr. Thomas Bogdan**, President, University Corporation for Atmospheric Research

Background

With a high potential for coverage gaps from NOAA's planned geostationary and polar orbiting satellite systems, it is critical to ensure continuous and robust streams of weather data to protect citizens, property, and safeguard the American economy. A report by the National Research Council in 2003 estimated that 80% of the data assimilated into numerical weather

models comes from satellites.[1] This figure has not demonstrably changed since then. NOAA's Global Data Assimilation System also uses observations from various land-based sensors like radar or sound wave wind profilers, balloons, aircraft, and buoys to formulate the Global Forecast System model.[2] NOAA relies upon different technologies, observing systems, and partnerships for data that is constantly available for use in formulating forecasts and predicting weather events to protect lives and property.

Satellite Observing Systems

NOAA operates two main types of satellites that provide weather data. The geostationary satellite program, called Geostationary Operational Environmental Satellites (GOES), constantly monitors the Earth. The geostationary satellite fleet is comprised of three satellites: One satellite monitors the western United States (GOES-WEST), one satellite monitors the eastern United States (GOES-EAST), and one spare satellite sits in orbit to provide backup duties in the event of satellite failures. NOAA's next geostationary satellite is planned for launch in 2016.

The polar satellite program, called the Polar Operational Environmental Satellites, monitors the Earth from 500 miles above, traversing the globe 14 times daily between the north and south poles as the Earth spins.[3] The current polar orbiting fleet consists of three satellites operating in the afternoon orbit, NOAA-15, NOAA-18, and NOAA-19, all with various degrees of age and performance.[4] NOAA's next polar orbiting satellite is planned for launch in 2017.

International Satellite Agreements and Cooperation

In addition to U.S. government-owned satellites, NOAA has partnerships to ensure robust data streams. The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) operates polar orbiting satellites that add coverage of the Earth in the mid-morning orbit.[5] These satellites comprise the Initial Joint Polar System Agreement (IJPS) between EUMETSAT and NOAA to share polar-orbiting satellite data.[6]

Likewise, there is historical context for geostationary satellite cooperation. EUMETSAT and NOAA now have formal collaboration to perform backup agreements in the event of a satellite failure. In 1985, Meteosat-2 (a European satellite) failed and was replaced by GOES-4

[1] National Research Council, "Fair Weather Report: Effective Partnership in Weather and Climate Services," 2003, available at: http://www.nap.edu/catalog/10610/fair-weather-effective-partnerships-in-weather-and-climate-services
[2] National Oceanic and Atmospheric Administration, "Global Data Assimilation System," 2012, available at: https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/global-data-assimilation-system-gdas
[3] National Oceanic and Atmospheric Administration, "Polar-orbiting Operational Environmental Satellites," 2014, available at: http://www.ospo.noaa.gov/Operations/POES/
[4] National Oceanic and Atmospheric Administration, "POES Operational Status," 2014, available at: http://www.ospo.noaa.gov/Operations/POES/status.html
[5] EUMETSAT, "Metop," 2015, available at: http://www.eumetsat.int/website/home/Satellites/CurrentSatellites/Metop/index.html
[6] Ibid.

to cover the operational gap over Europe.[7] In 1989, a NOAA satellite, GOES-6 failed and was aided by European satellite Meteosat-3 to cover the U.S. and Western Atlantic.[8]

NOAA also has relationships with other government organizations for weather data, including the Japan Meteorological Agency (JMA), Japan Aerospace Exploration Agency (JAXA), French Space Agency CNES), National Space Organization Taiwan (NSPO), Indian Space Research Organization (ISRO), Canadian Space Agency (CSA).[9]

Surface Observing Systems

NOAA also conducts observations and ingests datasets from surface-based observing systems. According to NOAA, "knowing the current state of the weather is just as important as the numerical computer models processing the data."[10]

NOAA operates land-based stations to collect data as part of its Automated Surface Observing System. Ground-based observing systems are located throughout the United States and collect data on various aspects of the atmosphere including ground temperature, humidity, precipitation, and wind speed.[11] NOAA also collects data from weather balloons with instruments called radiosondes that ascend through the atmosphere to collect data, which is then received by ground stations. The data from radiosondes are used for input into computer-based prediction models, local severe storm forecasts, and weather research.[12]

NOAA also acquires data on lightning through a partnership with Vaisala, a private sector company that uses ground based sensors to track lightning activity in the United States.[13] Of note, the raw data from this partnership is freely available throughout the U.S. government, and several derived products are openly available to all users.[14]

Aviation Observing Systems

NOAA also collects weather data from aviation-based observing systems. NOAA receives Aircraft Communications Addressing and Reporting System data (ACARS), as well as Aircraft Meteorological Data Relay (AMDAR). These systems provide data from commercial

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[7] European Space Policy Institute, "EUMETSAT – NOAA Collaboration in Meteorology from Space," 2013, available at: http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_46.pdf
[8] Ibid.
[9] National Oceanic and Atmospheric Administration, "Developing Partnerships," 2015, available at: http://www.nesdisia.noaa.gov/developingpartnerships.html
[10] National Oceanic and Atmospheric Administration, "Numerical Weather Prediction," 2015, available at: https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/numerical-weather-prediction
[11] National Oceanic and Atmospheric Administration, "Land-Based Station Data," 2015, available at: https://www.ncdc.noaa.gov/data-access/land-based-station-data
[12] National Oceanic and Atmospheric Administration National Weather Service, "Radiosonde Observations," 2015, available at: http://www.ua.nws.noaa.gov/factsheet.htm
[13] National Oceanic and Atmospheric Administration, "Lightning Products and Services," 2015, available at: https://www.ncdc.noaa.gov/data-access/severe-weather/lightning-products-and-services
[14] Ibid.

aircraft during flight. According to NOAA, "the participating airlines retain a proprietary interest in their data and therefore set the rules regarding to whom and how it may be redistributed." [15] Both data from ACARS and AMDAR are assimilated into NOAA's National Center for Environmental Prediction models.[16]

Ocean Observing Systems

Ocean activities relating to weather at NOAA are conducted under the Integrated Ocean Observing System (IOOS), a partnership between federal, regional, private sector, and the academic community to track, predict, manage, and adapt to changes in marine environments.[17] The primary technologies deployed for ocean observing systems are oceanographic buoys, sensors, and coastal radars. The various data from these systems include air temperature, water temperature, wind direction and speed, and wave heights.[18]

Data Policy

With the multiple observing systems in use by NOAA to collect environmental data, an understanding of NOAA's data policies is crucial as the Agency evolves in the future to take advantage of more data sources and methods of collection. NOAA's Office of Technology, Planning, and Integration of Observation (TPIO) is responsible for "identifying and documenting all current and planned observation systems providing data to meet NOAA observational requirements and conducting analyses to aid in the development of an integrated observing system portfolio."[19] This office is also responsible for assessing NOAA's observation requirements for current, planned, and conceptual observational capabilities, as well as the prioritization of requirements.[20]

The Agency relies on multiple documents to outline its policy on sharing environmental data. NOAA advocates the use of full and open data policies that allow for the sharing of important environmental data.[21] NOAA provides data to the world and receives data in return. According to NOAA's partnership policy website, the agency adheres to the policies contained in the Paperwork Reduction Act, the Government Paperwork Elimination Act, and OMB

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[15] National Oceanic and Atmospheric Administration National Weather Service, "ACARS/AMDAR Data," 2006, available at: http://www.nco.ncep.noaa.gov/sib/restricted_data/restricted_data_sib/acars+amdar/
[16] Ibid.
[17] National Oceanic and Atmospheric Administration National Ocean Service, "Integrated Ocean Observing System," 2014, available at: http://oceanservice.noaa.gov/programs/ioos.html
[18] NERACOOS, "About Ocean Observing Systems," 2014, available at: http://www.neracoos.org/about/ocean_observing
[19] National Oceanic and Atmospheric Administration Technology, Planning, and Integration for Observation, "NOAA Observing Systems," 2015, available at: https://www.nosc.noaa.gov/tpio/main/aboutosa.html
[20] Ibid.
[21] National Oceanic and Atmospheric Administration Satellite and Information Service, "Satellite and Data Policy," 2012, available at: http://www.nesdisia.noaa.gov/policy.html

Circular No.A-130.[22] The Agency is also guided by the National Space Policy of the United States of America, released in 2010.[23] In addition, the World Meteorological Organization's Resolution 40 established standards of sharing meteorological data openly, which is used by NOAA today.[24]

Additional Reading

- National Research Council. *Fair Weather: Effective Partnerships in Weather and Climate Services*. Washington, DC: The National Academies Press, 2003. Available at: http://www.nap.edu/catalog/10610/fair-weather-effective-partnerships-in-weather-and-climate-services
- National Research Council. Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks. Washington, DC: The National Academies Press. 2009. Available at: http://dels.nas.edu/Report/Observing-Weather-Climate-from/12540
- Committee on Science, Space, and Technology. *To Observe and Protect: How NOAA Procures Data for Weather Forecasting*. Washington, DC. 2012. Available at: http://science.house.gov/hearing/subcommittee-energy-and-environment-hearing-how-noaa-procures-data-weather-forecasting

[22] National Oceanic and Atmospheric Administration, "Policy on Partnerships in the Provision of Environmental Information," 2015, available at: http://www.noaa.gov/partnershippolicy/
[23] White House, National Space Policy of the United States of America," 2010, available at: https://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf
[24] World Meteorological Organization, "Resolution 40," 2015, https://www.wmo.int/pages/about/Resolution40_en.html

Chairman BRIDENSTINE. The Subcommittee on the Environment will come to order.

Without objection, the Chair is authorized to declare a recess of the Subcommittee at any time.

Welcome to today's hearing titled "Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts."

I recognize myself for five minutes for an opening statement.

Good morning and welcome to this hearing of the Subcommittee on the Environment. First, I would like to acknowledge that last night the House passed H.R. 1561, the Weather Research and Forecasting Innovation Act of 2015. I want to thank Chairman Smith for his continued leadership on this issue. I thank the Committee Vice Chairman, Mr. Lucas, for his sponsorship of the bill. As a fellow Oklahoman, I know he understands the vital need for this bill, and his involvement has been crucial to the success of H.R. 1561.

I also want to thank the Ranking Member of the Environment Subcommittee, Ms. Bonamici, for being the lead cosponsor and being so helpful to this effort. This bill is the result of a very bipartisan agreement and it is stronger for it. The Weather Research and Forecasting Innovation Act will improve our ability to accurately predict the weather and save lives and property.

This week, the Senate also introduced weather legislation, and I am glad that they are beginning to look at an issue that we here in the House have been looking at for a few years now. I look forward to working with our Senate counterparts and would encourage them to take up H.R. 1561 so that we can set in motion the improvements needed to better predict the weather.

Today's hearing continues this Subcommittee's focus on how the National Oceanic and Atmospheric Administration, NOAA, uses weather data to enhance their forecasting capability, how and where they get the necessary data, and how these processes can be improved.

A main tenant of our now House-passed weather legislation is its recognition of the role commercial weather data can play as a piece of the solution available to NOAA. A previous hearing of this Subcommittee looked into issues with NOAA's satellite programs that could lead to gaps in data. That hearing served to underscore my belief that we need to augment our space-based observing systems by incorporating alternative methods of data collection.

Today, we will hear from experts across multiple disciplines to better understand how NOAA currently incorporates external data, as well as what options are available to NOAA outside of traditional sources. For example, NOAA already purchases limited commercial data for various modeling and forecasts. These partnerships can serve as a model as NOAA necessarily evolves to meet its critical mission. Likewise, hosted payloads offer additional flexibility to the agency by providing space on commercial satellites that can host weather instruments and sensors, including proprietary NOAA instruments.

International partnerships also play an important role. Namely, NOAA's satellite partnership with the Europeans has historically been crucial when faced with satellite failures. Our partnership with Taiwan on the COSMIC and COSMIC–2 programs dem-

onstrates the value of new weather technology that will increase our ability to predict severe weather events in the near future.

Information from commercial aircraft sensors could also factor more into our data streams than it currently does. Additionally, we should look at how our unmanned aerial systems and how they play into this. In Oklahoma, there are people working every day to incorporate UAS into the airspace, including how they could be utilized to monitor the weather in areas where passenger aircraft do not fly.

One issue that will need to be addressed as new options for continuous, robust, and cost-effective data streams are explored, is how NOAA shares information it receives. This is a sensitive subject, I understand that, but it needs to be discussed. I am concerned that a viable commercial weather industry could face challenges under NOAA's current interpretation of how our international obligations regarding access to data are made.

However, we know that in practice NOAA does in fact purchase commercial data that they do not share, and that our international obligations are much more nuanced than are sometimes interpreted to being.

I know that Dr. Stephen Volz, head of NESDIS, has signaled his openness to commercial data, and I appreciate his very forward-looking view on this matter. He and other NOAA officials have sometimes couched their support with the caveat that data must be available for free to all. In some cases, this could hinder a free market for data or a market at all for data.

I'd like to use this hearing to kick-start the conversation on how we can craft a data policy that meets our international obligations, provides access to researchers and the academic community, and does not prevent the growth of this nascent industry.

I look forward to a lively discussion today that highlights the possibilities available to NOAA to add new sources of data and flexibility to enhance our weather forecasting systems.

[The prepared statement of Chairman Bridenstine follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON ENVIRONMENT
CHAIRMAN JIM BRIDENSTINE

Good morning and welcome to this hearing of the Subcommittee on the Environment.

First, I would like to acknowledge that last night the House passed H.R. 1561, the Weather Research and Forecasting Innovation Act of 2015. I want to thank Chairman Smith for his continued leadership on this issue. I thank the Committee Vice Chairman, Mr. Lucas for his sponsorship of the bill. As a fellow Oklahoman, I know he understands the vital need for this bill, and his involvement has been crucial to the success of H.R. 1561. I also want to thank the Ranking Member of the Environment Subcommittee, Ms. Bonamici, for being the lead co-sponsor. This bill is the result of a bipartisan agreement and is stronger for it. The Weather Research and Forecasting Innovation Act will improve our ability to accurately predict the weather and save lives and property.

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casting capability, how and where they get that necessary data, and how these processes can be improved.

A main tenant of our now House-passed weather legislation is its recognition of the role commercial weather data can play as a piece of the solutions available to NOAA. A previous hearing of this Subcommittee looked into issues with NOAA's satellite programs that could lead to gaps in data.

That hearing served to underscore my belief that we need to augment our space-based observing systems by incorporating alternative methods of data collection. Today we will hear from experts across multiple disciplines to better understand how NOAA currently incorporates external data, as well as what options are available to NOAA outside of traditional sources.

For example, NOAA already purchases limited commercial data for various modeling and forecasts. These partnerships can serve as a model as NOAA necessarily evolves to meet its critical mission. Likewise, hosted payloads offer additional flexibility to the Agency by providing space on commercial satellites that can host weather instruments and sensors, including proprietary NOAA instruments.

International partnerships also play an important role. Namely, NOAA's satellite partnership with the Europeans has historically been crucial when faced with satellite failures. Our partnership with Taiwan on the COSMIC and COSMIC-2 programs demonstrates the value of a new weather technology that will increase our ability to predict severe weather events in the near future.

Information from commercial aircraft sensors could also factor more into our data streams than it currently does. Additionally, we should look at how our unmanned aerial systems play into this. In Oklahoma, there are people working every day to incorporate UAS into the airspace, including how they could be utilized to monitor the weather in areas where passenger aircraft do not fly.

One issue that will need to be addressed as new options for continuous, robust, and cost-effective data streams are explored, is how NOAA shares the information it receives. This is a sensitive subject, but it needs to be discussed. I am concerned that a viable commercial weather industry will face challenges to mature under NOAA's current interpretation of our international obligations regarding access to data.

However, we know that in practice NOAA does in fact purchase some commercial data that they do not share, and that our international obligations are much more nuanced.

I know that Dr. Stephen Volz, head of NESDIS, has signaled his openness to commercial data, and I appreciate his forward-looking view. However, he and other NOAA officials have couched their support with the caveat that data must be made available, for free, to all.

I'd like to use this hearing to kick start the conversation on how we can craft a data policy that meets our international obligations, provides access to researchers and the academic community, and does not prevent the growth of this nascent industry.

I look forward to a lively discussion today that highlights the possibilities available to NOAA to add new sources of data and flexibility to enhance our weather forecasting systems.

Chairman BRIDENSTINE. I would like to now recognize the Ranking Member, the gentlewoman from Oregon, for an opening statement.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you to the witnesses for being here today.

I want to start by congratulating be Subcommittee Chairman on the passage of H.R. 1561, the Weather Research and Forecasting Innovation Act of 2015, on the House Floor yesterday. We've been working on this together for a couple of years. I know the Chairman shares my interest in doing all we can to protect the American people from severe weather events. The legislation we've been working on together will go a long way in improving the nation's weather forecasting capabilities.

I'm also pleased that we're holding today's hearing to discuss the benefits and challenges associated with advancing the role of commercial weather data in our national weather enterprise. The legislation passed yesterday takes an important first step towards

strengthening and improving NOAA's partnerships with the private sector. But there are several issues that NOAA and this Subcommittee need to work through to achieve the appropriate balance. The complexity of such a transition is why I'm glad we're holding this hearing today.

And as impressive as our witness panel is this morning, any discussion of this topic is incomplete without also hearing from NOAA. And I understand that NOAA was invited but unable to attend on this particular date because of time constraints, but, Mr. Chairman, I trust that we can find another time to hear directly from NOAA about their current policies and challenges that they see with expanding the purchase and use of commercial weather data. Nevertheless, I'm looking forward to this morning's discussion.

As we're exploring a path forward for commercial weather data, it's important for us to first understand the history of the partnership between NOAA and the private sector. It's a long and fruitful partnership. Currently, NOAA procures the nation's geostationary and polar satellites through contracts with the private sector. This government-owned commercially operated structure provides critical observational data that's the backbone of our numerical weather prediction and it's based on the premise that government information is a valuable resource and a public good. Therefore, the data gathered by these satellites and used by NOAA is made available to the public. The preservation of full and open access to core data products is essential and it's enabled the growth of the whole weather enterprise, public and private.

Policies that enable the sharing of data and information with the research community, our international partners, and commercial entities has brought the weather industry to where it is today. This billion-dollar industry owes much of its success to these open-data policies, and I'm concerned about whether and how the industry will continue to grow if we were to dramatically alter these open-access policies.

NOAA also has a history of incorporating commercial weather data into its products and services. For example, we'll hear today from a company that provides NOAA with real-time lightning data, which is essential for its severe weather warnings and forecasts. All of these external data sources are valuable but they supplement observations from government satellites; they do not replace them. If we're moving toward a model where the government is solely a purchaser, not a provider, of weather data, then there are a number of unique challenges and important questions that must be addressed to ensure the stability, credibility, and reliability of the nation's weather forecasting capabilities.

And, Mr. Chairman, you began to list some but I'm going to add specifically; can NOAA freely share the data it purchases? If not, what would that mean for maintaining our international obligations? If NOAA maintains its policy of free and unrestricted use of data it purchases, will it be forced to purchase data at a premium that will outweigh the anticipated cost savings?

Now, there are several other issues we could discuss but these are the kinds of questions NOAA has been wrestling with while developing policies and practices for purchasing commercial data over

the years. I know they're still working hard to address these questions and others, and again, Mr. Chairman, I want to emphasize that we need NOAA to be a part of these discussions going forward.

I know everyone involved in the weather enterprise from NOAA to its industry partners and our talented researchers are all working toward the same goal of advancing our ability to forecast the weather, save lives, and improve our economy in the process. As we identify ways for NOAA to work more closely with industry to incorporate commercial weather data into its models, products, and services, we must be mindful of the risks.

So thank you, Mr. Chairman, and again, thank you to our witnesses for being here this morning. And I yield back the balance of my time.

[The prepared statement of Ms. Bonamici follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON OVERSIGHT
MINORITY RANKING MEMBER SUZANNE BONAMICI

Thank you, Mr. Chairman, and thank you witnesses for being here today. I want to start by congratulating the Chairman for passage of H.R. 1561, the Weather Research and Forecasting Innovation Act of 2015 on the House floor yesterday. I know he shares my interest in doing all we can to protect the American people from severe weather events, and the legislation we worked on together will go a long way in improving the nation's weather forecasting capabilities.

I am also pleased that we are holding today's hearing to discuss the benefits and challenges associated with advancing the role of commercial weather data in our National weather enterprise. Our legislation takes an important first step toward strengthening and improving NOAA's partnerships with the private sector. However, there are a number of issues that NOAA and this Subcommittee need to work through to achieve the appropriate balance. The complexity of such a transition is why I am glad we are holding today's hearing. As impressive as our witness panel is this morning, however any discussion of this topic is incomplete without also hearing from NOAA. I understand that NOAA was unable to be here today because of time constraints, but Mr. Chairman, I trust that we can find another time to hear directly from NOAA about their current policies and any challenges they see with expanding the purchase and use of commercial weather data. Nevertheless, I am looking forward to this morning's discussion.

As we are exploring a path forward for commercial weather data, it is important for us to first understand the history of the partnership between NOAA and the private sector. It is a long and fruitful partnership. Currently, NOAA procures the nation's geostationary and polar satellites through contracts with the private sector. This government owned, commercially operated structure has served us well. It has provided critical observational data that is the backbone of our numerical weather prediction and is based on the premise that government information is a valuable resource and a public good. Therefore, the data gathered by these satellites, and used by NOAA, is made available to the public.

The preservation of full and open access to core data products is essential and has enabled the growth of the whole weather enterprise-public and private. Policies that enable the sharing of data and information with the research community, our international partners, and commercial entities, has brought the weather industry to where it is today. This billion dollar industry owes much of its success to these open data policies and I'm concerned about whether and how the industry will continue to grow if we dramatically alter these open access policies.

NOAA also has a history of incorporating commercial weather data into its products and services. For example, we will hear today from a company that provides real-time lightning data to NOAA, which is essential for its severe weather warnings and forecasts. All of these external data sources are valuable, but they supplement observations from government satellites, they do not replace them.

If we are moving toward a model where the government is solely a purchaser, and not a provider, of weather data then there are a number of unique challenges and important questions that must be addressed to ensure the stability, credibility, and reliability of the nation's weather forecasting capabilities.

Specifically, can NOAA freely share the data it purchases?

If not, what would that mean for maintaining our international obligations?

If NOAA maintains its policy of free and unrestricted use of data it purchases, will it be forced to purchase data at a premium that will outweigh the anticipated cost savings?

I could go on, but these are the kinds of questions NOAA has been wrestling with while developing policies and practices for purchasing commercial data over the years. I know they are still working hard to addresses these questions and others and again, Mr. Chairman I want to emphasize that we need NOAA to be a part of these discussions going forward.

I know everyone involved in the weather enterprise from NOAA to its industry partners to our talented researchers are all working toward the same goal of advancing our ability to forecast the weather, save lives, and improve our economy in the process. As we identify ways for NOAA to work more closely with industry to incorporate commercial weather data into its models, products, and services, we must be mindful of the risks.

Thank you, Mr. Chairman, and again thank you to our witnesses for being here this morning. I yield back the balance of my time.

Chairman BRIDENSTINE. I'd like to thank the Ranking Member for her opening statement.

Just for a matter of record, we agreed to this hearing on May 1, 20 days ago. On May 4, 16 days ago, we did invite NOAA. They indicated that that wasn't sufficient time to be here and testify.

So I'd like to introduce our witnesses now. Our first witness is Dr. Scott Pace, Director of George Washington University's Space Policy Institute. Before joining the university, Dr. Pace was Associate Administrator for Program Analysis and Evaluation at NASA. In addition, he served as the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy. Dr. Pace received his bachelor's degree in physics from Harvey Mudd College, master's degrees in aeronautics and astronautics and technology and policy from MIT, and his Ph.D. in policy analysis from RAND Graduate School. Thank you for being here, Dr. Pace.

Mr. Scott Sternberg is our next witness, President of Vaisala Inc. At Vaisala, Mr. Sternberg is responsible for the regional governance of the company's U.S.-based operations. Before joining Vaisala, Mr. Sternberg specialized in providing advanced digital imaging solutions to scientific applications at Roper Industries Photometrics. Mr. Sternberg serves on the Board of Trustees for the University Corporation of Atmospheric Research, or UCAR, and as Chairman of the Board of Directors for CO-LABS. Mr. Sternberg received his bachelor's degree in physics from the State University of New York College at Cortland and his master's degree in physics and spectroscopy from Colorado State University.

Ms. Nicole Robinson is our next witness, Chair of the Hosted Payload Alliance. Ms. Robinson also serves as the Corporate Vice President of Government Market Solutions Center at SES Government Solutions and on the Board of the Washington Space Business Roundtable. In 2012 she was the recipient of the Future Leaders Award by the Society of Satellite Professionals International. Ms. Robinson received her bachelor's degree in communications from Radford University and her MBA from Liberty University. In addition, she's a graduate of the Senior Executives and National and International Security Program at Harvard University.

Dr. Bill Gail is our next witness, Cofounder and Chief Technology Officer of the Global Weather Corporation. Prior to joining GWC, Dr. Gail served as President of the American Meteorological

Society. He has worked over two decades in the fields of meteorology services, satellite meteorology, and location-aware software. In addition, he recently served as the U.S. National Academy of Sciences, NAS, Research Council Committee reviewing the National Weather Service modernization program. Dr. Gail received his bachelor's degree in physics and his Ph.D. in electrical engineering from Stanford University.

Dr. Thomas Bogdan is our final witness, President of the University Corporation for Atmospheric Research, UCAR. Dr. Bogdan leads UCAR in its mission of providing science in service to society through innovative partnerships with more than 100 member colleges and universities in the UCAR consortium. Before joining UCAR, Dr. Bogdan served as Director of NOAA's Space Weather Prediction Program where he helped transition the first numerical space weather prediction model into operations. Prior to joining NOAA, Dr. Bogdan served as the National Science Foundation's Program Director for Solar Terrestrial Physics. Dr. Bogdan received his bachelor's degree in physics and mathematics from the State University of New York at Buffalo and his master's and Ph.D. in physics from the University of Chicago. Needless to say, we have a bunch of smart people today.

In order to allow time for discussion, please limit your testimony to five minutes.

I would ask unanimous consent—we have the gentleman from Colorado here. I'd ask unanimous consent—he's not on the Subcommittee but maybe today we could have you as an honorary member of the Subcommittee because of your interest in this topic. With unanimous consent, we'll have the gentleman from Colorado join us on this committee.

Ms. BONAMICI. I have no objection, Mr. Chairman.

Chairman BRIDENSTINE. No objection.

In order to allow time for discussion, please limit your testimony to five minutes. Your entire written statement will be made a part of the record.

I now recognize Dr. Pace for five minutes to present his testimony.

TESTIMONY OF DR. SCOTT PACE, DIRECTOR, SPACE POLICY INSTITUTE, GEORGE WASHINGTON UNIVERSITY

Dr. PACE. Okay. Thank you, Mr. Chairman. And thanks to the Ranking Member and the Members of the Committee for the opportunity to discuss the important topic of weather data policies and the challenges facing NOAA in the utilization of commercial remote sensing data.

From 1990 to 1993 I was a civil servant in the U.S. Department of Commerce working in the Office of Space Commerce and the Office of the Deputy Secretary. I believe the Office continues to have an important role to play in promoting the growth of the U.S. commercial space activity and I was personally glad to see the support for approval of H.R. 2263, the Office of Space Commerce Act.

While at Commerce, I had the privilege of working on Title II of the Land Remote Sensing Policy Act with Barry Beringer, the former Chief Counsel of the House Committee on Science. Title II

reformed the U.S. Commercial Remote Sensing Licensing process and removed a number of regulatory barriers to space-based commercial remote sensing. This reform helped foster a more dynamic U.S. industry that is globally competitive today and created the new options that I think we're looking at for NOAA today.

NOAA is facing both opportunities and challenges in taking advantage of an increasingly sophisticated, innovative commercial remote sensing industry to meet its mission needs. Industry capabilities are greater than ever before but so are the budget pressures and expectations being placed on NOAA to meet the nation's need for weather forecasting and warning.

I'm currently a member of the NOAA Advisory Committee on Commercial Remote Sensing known as ACCRES. Our committee has noted these global trends and in particular the increasing promise of small satellite constellations and unmanned air vehicles to provide innovative services. Securing benefits from private data sources requires both a shift in the agency's mindset and appropriate resources for its implementation, both financial and human capital.

ACCRES summarized its concern in a February 2015 letter to the Secretary of Commerce on Commercial Remote Sensing and I've included that in my written testimony for your consideration.

The Commercial Remote Sensing Act of 2015, H.R. 2261, I believe, is a constructive step in addressing the challenges faced by NOAA in meeting its regulatory responsibilities. The agency needs to both streamline its processes and receive additional resources to meet a growing workload. NOAA also needs the active cooperation of other agencies, notably the Departments of State and Defense in more quickly adjudicating license applications. Delays and uncertainties in licensing new technical capabilities are impeding the ability of U.S. firms to innovate and puts them at risk of following, not leading, their global competitors.

I would point out that commercial remote sensing data really isn't an option until you get the license, until you get the satellites on orbit.

NOAA is facing important risks internationally as well. The United States has been the leader in openly sharing environmental data from civil scientific satellites with researchers worldwide. This practice is not as widely followed as the scientific community would like with many of our partners. Access to international environmental data sets for climate change research is uneven in some countries hoping to monetize the data in a commercial-like manner. Some foreign firms—forms of public-private partnerships created in response to their own domestic budget constraints also encourage restrictions that constrain scientific research in an effort to gain revenue.

Another source of risk affecting public and private remote sensing alike is radiofrequency interference, in particular, commercial demand for spectrum to support terrestrial mobile broadband services has increased pressures on many bands used for space services and scientific applications. Sensitive GPS radio occultation measurements use receivers with a very wide front ends to acquire weak signals, accurate measurements would be impaired if high-powered

communication networks were to be deployed in the bands adjacent to GPS.

NOAA can and should be a leader in fostering the competitiveness of U.S. commercial remote sensing industry through its regulatory role. It can and should be a leader in promoting scientific cooperation and data sharing in accordance with international data sharing principles of the Group on Earth Observations.

NOAA is at the center of a rapidly changing global environment in which it can leverage private sector capabilities to meet public needs. In order to succeed, however, NOAA needs to proactively shape the rules and practices of this environment and not merely respond to it. And I commend this hearing for starting the conversation to balance some of the data policy issues I think that we're all struggling with.

Thank you for your attention and I'm happy to answer any questions you might have.

[The prepared statement of Dr. Pace follows:]

Hearing of the House Committee on Science, Space, and Technology
Subcommittee on Environment

"NOAA Utilization of Commercial Remote Sensing Data"

Wednesday, May 20, 2015 - 10:00 AM – RHOB 2318

Testimony of Dr. Scott Pace
Director, Space Policy Institute
Elliott School of International Affairs
The George Washington University

Thank you, Mr. Chairman, for providing an opportunity to discuss the important topic of weather data policies and the challenges facing NOAA in the utilization of commercial remote sensing data.

From 1990 to 1993, I was a civil servant in the U.S. Department of Commerce, working in the Office of Space Commerce in the Office of the Deputy Secretary. I believe the Office continues to have an important role to play in promoting the growth of U.S. commercial space activity and I was glad to see the support from this Committee in its approval of H.R. 2263, the Office of Space Commerce Act.

While at Commerce, I had the privilege of working on Title II of the Land Remote Sensing Policy Act with Barry Beringer, the former chief counsel of the House Committee on Science. In the aftermath of the Cold War, Title II reformed the U.S. commercial remote sensing licensing process and removed regulatory barriers to space-based commercial remote sensing. This reform was successful beyond our somewhat modest expectations, leading to a more dynamic, information-driven global industry.

The idea of buying data from commercial sources for the needs of NOAA is not a new one. While at Commerce, we had debates over whether NOAA should explore the purchase of wind profile information and perhaps be an "anchor tenant" for newly emerging firms. We did not pursue this course as NOAA's limited budget was already committed to existing programs with well-known requirements. Funds were not available for experiments; even ones that offered long-term cost savings.

While at Commerce, we worked with the National Space Council on policy guidelines to encourage the growth of commercial space activities. We recognized the many different roles the government might play, not only as a customer and anchor tenant, but also as a regulator and support of R&D that was too risky for the private sector. Years later at NASA, these ideas of using government supports and purchasing power to leverage private sector innovation were put into practice in the commercial cargo program for the International Space Station.

Today, NOAA is facing both opportunities and challenges in taking advantage of an increasingly sophisticated, innovative commercial remote sensing industry to meet its mission needs. Industry capabilities are greater than ever before, but so are the budget pressures and expectations placed on NOAA to meet the nation's needs for weather forecasts and warnings.

Global Trends

Access to space-based information capabilities and technologies is virtually ubiquitous, and access to space launch services is nearly so. The past decade has witnessed an increasing number of mostly American entrepreneurial firms seeking non-traditional markets. The growth of Big Data and location-based services applications has created significant new demand for geospatial data. The fusion of data from multiple sources will allow motivated nations, multinational companies, and even small groups or individuals to improve their access to previously unavailable information that can have potential strategic implications.

Private capital and sovereign wealth funds are reshaping international space markets. The amount of investment funds available from major U.S. information technology firms is such that they can acquire almost any space-based information technology they may require. Along with capital sources, international models of satellite ownership are changing. Countries are increasingly able to satisfy their space data and communications requirements through services from satellites they do not own.

The significance of private funding and development of new capabilities is coupled with the reality of globalization. Not only are modern space capabilities becoming ubiquitous but private funding also means that new and unexpected capabilities may be developed elsewhere in the world. To date, it has been to the advantage of the United States that innovative space activities have been concentrated in U.S. companies. This advantage is predicated on a timely and responsive domestic regulatory process and favorable economic conditions, but these cannot be assumed to be a given.

Unfortunately, the U.S. Government is adapting too slowly to these changes to mitigate harm to an industrial base more suited to the unique but increasingly expensive and slow government approach in areas such as space launch and space platform architectures. At the same time, the U.S. Government is not effectively positioned to leverage the potential opportunities and benefits from these trends.

Commercial Remote Sensing Regulation

I am currently a member of the NOAA Advisory Committee on Commercial Remote Sensing (ACCRES). Our committee has noted these global trends and in particular, the increasing promise of small satellite constellations and unmanned air vehicles to provide innovative services. The world of commercial remote sensing today is very

different from that of January 1993 when the Department of Commerce issued the first high-resolution (three-meter) license for a commercial electro-optical satellite. Commercial data sources are of great important to meeting the needs of the National Geo-spatial Intelligence Agency but they cannot replace the capabilities of the National Reconnaissance Office. Similarly, commercial data sources are unlikely to replace the GOES and POES satellites used by NOAA. Private firms can, in particular cases, complement government capabilities in ways that lower the overall cost and risk of meeting the agency's mission.

Securing benefits from private data sources is not easy. In particular it requires both a shift in the agency's mindset and appropriate resources for implementation, both financial and human capital. ACCRES summarized its concerns in a February 2015 letter to the Secretary of Commerce, and I would like to highlight a few key points that apply to NOAA's weather data needs as well as to U.S. government policy toward commercial remote sensing more generally.

On government regulation in a changing world:

> In order to maintain leadership and U.S. strength in this area, the Committee believes that a fundamental rethinking about satellite remote sensing – and especially commercial remote sensing – is necessary as the driver of the U.S. government's approach to policy and regulation. Agencies continue to think about remote sensing as a traditional aerospace technology when, in fact, it is increasingly an information technology, requiring a different regulatory philosophy and regulatory actions.
>
> Increasingly, U.S. firms are shifting from the traditional business model of selling images to one of conveying information from satellite imagery combined with a number of sources. Agencies also continue to harbor a view that space-based assets should be considered differently from a wide range of emerging sensors – such as drones – within a rapidly changing geospatial ecosystem. While historically understandable, this perspective is increasingly obsolete.
>
> We submit that U.S. government stakeholders must tailor policy and regulations to reflect the fact that remote sensing is no longer a U.S.-only, exclusively satellite-based effort, but is instead a global information technology that relies on a wide range of platforms.

On NOAA resources for commercial remote sensing licensing:

> The Committee recognizes NOAA's daily efforts to perform a wide range of regulatory functions on behalf of the Department, especially with respect to licensing, license follow-up actions, compliance monitoring and enforcement. One of the most important challenges, as with most technologies, is that effective regulation is often slowed down by outdated law, policy, regulatory requirements or

practice, thereby hindering the effective application of limited agency resources from the areas most needed or of greatest risk.

The Committee finds NOAA's resources to be inadequate to the tasks that it has to perform in support of U.S interests. There has also been an explosion in the numbers of foreign and domestic ground stations for NOAA/NESDIS to inspect – which it is required to do each year by law – with an estimated 100 sites in over 20 countries expected by FY 2016. A corresponding increase in foreign agreements is expected to be required in the coming years.

Herein lies an important paradox: we have a U.S. policy that directs us to lead, yet because of restrictive thinking, U.S. firms are unable to exploit our own technology to directly compete with foreign competitors. The Committee believes that NOAA needs a new approach to receive, process, and respond quickly to its constituents, given this astonishingly fast-paced remote sensing environment.

We also believe that NOAA and the Department have the authorities to create relief from impractical regulatory enforcement actions, such as the need to visit ground stations. Today, a smart phone or tablet could effectively function as a ground station; and thus as a practical matter, NOAA should be allowed to shift the enforcement and inspection missions to a verification and complaint-driven inspection system to better manage compliance risks.

The Commercial Remote Sensing Act of 2015 (H.R. 2261) is a constructive step in addressing the challenges faced by NOAA in meeting its regulatory responsibilities. The agency needs to both streamline its processes and receive additional resources to meet a growing workload. NOAA also needs the active cooperation of other agencies, notably the Departments of State and Defense, in more quickly adjudicating license applications. Delays and uncertainties in licensing new technical capabilities are impeding the ability of U.S. firms to innovate and puts them at risk of following, not leading, global competitors.

NOAA is facing important risks in commercial remote sensing other than a lack of regulatory resources. The United States has been a leader in openly sharing environmental data from civil scientific satellites with researchers worldwide. This practice is also followed by many countries, but not as widely as the scientific community would like. Access to international environmental data sets for climate change research is uneven with some countries hoping to monetize the data in a commercial-like manner. Some forms of public-private partnerships, created in response to domestic budget constraints, also encourage restrictions that constrain scientific research in an effort to gain revenue.

If the government needs certain kinds of data, an independent and objective "build versus buy" analysis can help decide whether it should own and operate its own system or buy the data from an outside supplier. In some cases, the rights to access and distribute privately owned data for scientific research might simply need to be

purchased. The government has no right to free access to other forms of private intellectual property even for purposes of scientific research. On the other hand, as the experience with Landsat showed, efforts to sell many kinds of space-derived data may make no economic sense. Free distribution of data can result in greater public and private benefits if users are not initially deterred by prices, even low ones. The promotion of commercial remote sensing is sometimes seen as being in competition with the open exchange of scientific data, as defined by the data sharing principles of the Group on Earth Observations. This need not be the case and a "one size fits all" policy should be avoided that either infringes on private property rights or encourages governments to act like for-profit firms.

Another source of risk, affecting public and private remote sensing alike, is radiofrequency interference. In particular, the commercial demand for spectrum to support terrestrial mobile broadband services has increased pressures on many bands used for space services and scientific applications. The problem is particularly acute in the 1-3 GHz range. GPS radio occultation measurements use receivers with very wide front-ends to acquire weak signals. Accurate measurements would be impaired if high-powered communications networks were to be deployed in the bands adjacent to GPS. Protection of radio spectrum is a foundational requirement for ensuring the utility of GPS and Earth exploration satellite services (EESS) used by NOAA and NASA. A recent study by The Aerospace Corporation shows potential interference to the Emergency Managers Weather Information Network as a result of LTE (Long Term Evolution, a standard for wireless communications) operations in the 1695-1710 MHz band.

Choices for Government Use of Commercial Data

The purchase of data as opposed to ownership of a satellite system means a subtle shift in the role of the agency toward being a consumer of what industry chooses to provide rather than a customer who specifies what is to be provided. For agencies, including NOAA, there are strengths, weaknesses, opportunities, and threats associated with the use of commercial data and public-private partnerships to meet their mission needs. Among the strengths and opportunities are the potential for cost savings, more rapid innovation, and the alignment of private investment with public good needs. Among the weaknesses and threats are a loss of in-house expertise, dependency on private resources for the performance of public missions, and fewer mechanisms for agency control of cost, schedule, and performance.

For policy-makers, a fundamental question is what the respective roles of government and industry should be. If public funds are being expended, then there should be a mission focus on creating a public good. Exactly how those public goods are created can be debated. Private, commercial benefits are a desirable but secondary objective. Purchases of commercial data should be in response to meeting the priorities and requirements of the government.

For policy-makers and industry, a second task is getting the market analysis correct. Privatization is when industry provides goods and services previously provided by governments. Commercialization is a more difficult task in that industry has to serve private demand in addition to government demand. Meeting private market demand with competing private providers using private capital at risk is the essence of commercialization. It can be difficult to assess the size of addressable markets for new data products and judge the amount of capital required to come to market. Yet doing so is a necessity in deciding whether a commercial data buys are viable and sustainable.

For agency leaders, they need to conduct their own analyses of alternatives in how to best meet their mission requirements. In deciding whether to "make" data with their own system or to "buy" data from others, NOAA needs to decide how to allocate risks between what it provides and what it expects others to provide, to assess the regret costs if a private provider fails to perform as expected, and what fallback options exist. Most critically, NOAA needs to gain and retain in-house expertise to ensure due diligence and oversight of public funds, whether used for traditional acquisitions, public-private partnerships, or commercial purchases.

Finally, policy-makers and agency leaders need to decide how to balance a diverse set of national interests in commercial remote sensing. Through an enlightened regulatory regime, the promotion of space commerce can be done in ways that also advance U.S. national security and international leadership. Similarly, through enlightened partnerships with the private sector, public goods in scientific research, weather forecasting, and environmental stewardship can be gained at less cost and with greater innovation. In doing so, the United States can be a model and shaper of international practices as space capabilities become more global and diverse.

Conclusions

Given the critical importance of NOAA's weather satellite programs, the first priority should be the on-time implementation of the current GOES and POES programs. These are unique platforms that will not be soon replaced by commercial providers.

Second, NOAA should foster the creation of private sector options to meet its needs, much as NGA has done in working with U.S. industry to meet national security needs. In acquiring commercial data, NOAA should be ensure that it gets sufficient rights so that data sets can be shared for scientific, non-commercial purposes. It should ensure that it has sufficient insight into how the data were generated so that scientific peer review can independently assess conclusions based on those data.

There should be procurement "on-ramps" to enable experimentation and large-scale innovation in parallel with current government systems and international partnerships. In its own self-interest, NOAA should be open to alternatives as industry develops. It will be more risky to pursue only traditional acquisitions

without a mixed portfolio that includes non-traditional and commercial procurements.

In cooperation with the space industry, NOAA should be a strong domestic and international advocate of preventing interference to the radio spectrum upon which it relies. This particularly includes the Meteorological Aids Service (MetAids) used by radiosondes, the Earth Exploration Satellite Service (EESS) used for remote sensing, and the Radionavigation Satellite Service (RNSS) used by GPS. Spectrum protection is and will continue to be challenging due to commercial demands for more spectrum.

Finally, NOAA can and should be a leader in fostering the competitiveness of the U.S. commercial remote sensing industry through its regulatory role. It also can and should be a leader in promoting scientific cooperation and data sharing in accordance with the international data sharing principles of the Group on Earth Observations. NOAA is at the center of a rapidly changing global environment in which it can leverage private sector capabilities to meet public needs. In order to succeed, NOAA needs to proactively shape the rules and practices of this environment and not merely respond to it.

Thank you for your attention. I would be happy to answer any questions you might have.

Attachment A – Letter from ACCRES to the Secretary of Commerce

February 2015

Memorandum to:	The Secretary of Commerce Administrator, NOAA Assistant Administrator for Satellites and Information Services, NOAA
From:	Advisory Committee on Commercial Remote Sensing (ACCRES)
Subject:	Perspectives and Outlook on U.S. Commercial Remote Sensing

The purpose of this memorandum is to convey the Committee's perspectives and outlook on U.S. commercial remote sensing, consistent with our charter under the Federal Advisory Committee Act (5 U.S.C. 5). It also details the Committee's projected work plans, with NOAA's endorsement. The ideas offered here are for your general consideration; most importantly, a number of them pertain to expected U.S. national security decision meetings that you will be invited to participate in over the next few months.

In sum, we are concerned that a combination of factors puts U.S. leadership in commercial remote sensing at risk. We have not yet adapted our mindset to the shift of these capabilities from an aerospace technology to an information technology, and how that should affect policy and regulation. We are also concerned that the deep national security legacy often creates an imbalanced view of the wide range of impacts created by commercial remote sensing, which also undermines U.S. policy goals.

BACKGROUND AND CONTEXT

The world of satellite remote sensing is changing dynamically, with important consequences for U.S. commercial, foreign policy and national security interests. U.S. policy needs to be able to respond quickly to such change, lest there be unintended consequences for these interests. NOAA bears important licensing, compliance monitoring, enforcement and other regulatory responsibilities on behalf of the U.S. government, as well as coordination of inputs provided by other U.S. government agencies. NOAA also plays an important role in helping shape national policy related to commercial remote sensing, and by extension on global developments.

ACCRES is chartered to provide information, advice and recommendations to the Under Secretary of Commerce for Oceans and Atmosphere on matters related to the U.S. commercial remote sensing space industry, and on NOAA's activities to carry out the responsibilities of the Department of Commerce set forth in the National and Commercial Space Programs Act of 2010 (51 U.S.C. 60101 *et seq.*). The perspectives shared here are based on our decades of broad and deep experience with remote sensing issues that include detailed study of global remote sensing markets, involvement in a wide range of national security activities, and commercial industry practice.

In many ways, the United States has achieved the bold bipartisan vision laid out for leadership in commercialization of remote sensing satellites since the 1970s and reasserted in national space policy in 1994 (PDD-23) and again in 2003 (NSPD-27). While current national policy affirms U.S. intent to lead in this area, that goal is often undermined by a failure to fully implement policy guidance, due to agency mindsets and actions. These drag heavily on U.S. interests in a dynamically changing global satellite remote sensing market and an expanding global geospatial ecosystem that includes terrestrial, airborne and space components.

It is the view of this Committee that a combination of internal NOAA issues, external U.S. national security perspectives and a variety of other issues have put U.S. leadership in commercial remote sensing at risk. We detail some of those issues here, along with some ideas on how to bring agency actions into better compliance with national policy directions.

CHANGING OUR MINDSET

The United States has an extraordinary legacy in the use of satellite remote sensing for military and intelligence purposes, and increasingly for civil, environmental and commercial purposes. The nation's use of satellite remote sensing for security, public safety and scientific purposes remains unparalleled today. However, this great accomplishment is sometimes overshadowed by concerns over how information generated by remote sensing satellites is used by others. While countries like Canada, France, Israel and Japan have well-established satellite capabilities, countries like Azerbaijan, Egypt and Vietnam are taking advantage of fast-moving satellite technology and processing developments to become new entrants in the market. A country no longer needs its own domestic space industry to have access to world-class space-based information capabilities. Emerging space powers represent sources of technology, learning, business models and innovation that challenge U.S. interests.

In order to maintain leadership and U.S. strength in this area, the Committee believes that a fundamental rethinking about satellite remote sensing –and especially commercial remote sensing –is necessary as the driver of the U.S. government's approach to policy and regulation. Agencies continue to think about remote sensing as a traditional aerospace technology when, in fact, it is increasingly an information technology, requiring a different regulatory philosophy and regulatory actions. Increasingly, U.S. firms are shifting from the traditional business model of selling images to one of conveying information from satellite imagery combined with a number of sources. Agencies also continue to harbor a view that space-based assets should be considered differently from a wide range of emerging sensors – such as drones – within a rapidly changing geospatial ecosystem. While historically understandable, this perspective is increasingly obsolete. We submit that U.S. government stakeholders must tailor policy and regulations to reflect the fact that remote sensing is no longer a U.S.-only, exclusively satellite-based effort, but is instead a global information technology that relies on a wide range of platforms.

INTERNAL NOAA ISSUES

The Committee recognizes NOAA's daily efforts to perform a wide range of regulatory functions on behalf of the Department, especially with respect to licensing, license follow-up actions, compliance monitoring and enforcement. One of the most important challenges, as with most technologies, is that effective regulation is often slowed down by outdated law, policy, regulatory requirements or practice, thereby hindering the effective application of limited agency resources from the areas most needed or of greatest risk.

The Committee finds NOAA's resources to be inadequate to the tasks that it has to perform in support of U.S interests. Over 40 licenses have been issued in the five years since FY 2010, as compared to 26 between FY 1996 – 2010. There has also been an explosion in the numbers of foreign and domestic ground stations for NOAA/NESDIS to inspect – which it is required to do each year by law – with an estimated 100 sites in over 20 countries expected by FY 2016. A corresponding increase in foreign agreements is expected to be required in the coming years.

Technical and business model innovations by current and prospective U.S. licensees push the regulatory envelope: developments involving smaller satellites, new sensor types (e.g., video, hyperspectral) and U.S. satellite companies participating on foreign platforms or in foreign constellations require careful consideration from a regulatory perspective. Herein lies an important paradox: we have a U.S. policy that directs us to lead, yet because of restrictive thinking, U.S. firms are unable to exploit our own technology to directly compete with foreign competitors. The Committee believes that NOAA needs a new approach to receive, process, and respond quickly to its constituents, given this astonishingly fast-paced remote sensing environment.

We also believe that NOAA and the Department have the authorities to create relief from impractical regulatory enforcement actions, such as the need to visit ground stations. Today, a smart phone or tablet could effectively function as a ground station; and thus as a practical matter, NOAA should be allowed to shift the enforcement and inspection missions to a verification and complaint-driven inspection system to better manage compliance risks.

WORK OF THE NOAA INTELLIGENCE TASK GROUP

Last month, NOAA created an Intelligence Task Group to consider the classified viewpoints of the Department of State, the Department of Defense and the Intelligence Community. This Task Group was given only a very short period of time to interact with NOAA and other U.S. government colleagues. Yet this discussion is vitally important, both to the Committee's efforts as well as to the broader U.S. government conversation that must take place, as soon as possible. Security considerations have added both time and complexity to NOAA's regulatory requirements, as noted above.

The work of the Task Group is classified, so we can only share general observations here. The Committee is very concerned that the security perspectives on U.S. commercial remote sensing remain locked in an anachronistic and outdated mindset, especially with regard to

attempts to limit collection or commercial sale of imagery data (known also as "shutter control" or more recently as "modified operations").

Current security assessments, in the opinion of the Task Group, do not reflect an objective understanding of the uniqueness of U.S. commercial satellite imagery in supporting a variety of missions. U.S. capabilities are looked at overwhelmingly through the lens of how they are aiding our adversaries in achieving their aims. The assessments tend to amplify potential threats to U.S. security interests from commercial satellite imagery while downplaying the benefits of them, such as in their role supporting humanitarian operations, providing shareable information to diplomatic and military allies, or as sources of innovation. Assessments also frequently neglect to mention the many other ways in which an adversary can gain information even if U.S. systems are restricted, such as from foreign commercial satellites, or even how U.S. security aims might be reached without restrictions. They also fail to recognize the decades of trust, in practice, between U.S. industry and the U.S. government on security matters. Most importantly, they tend to value short-term, parochial considerations over longer-term, strategic interests of the United States. In short, the current approach is creating greater risks for the United States than is necessary or desirable.

Further, these assessments often fail to recognize the real world blending of many other technologies that are, in effect, creating both spatial and temporal transparency. Many advanced capabilities such as GPS, data from cell phones, UAVs, social media and others are being merged with U.S. and foreign commercial satellite imagery in geographic information systems in order to create extremely sophisticated and high value information. Consequently, treating commercial satellite imagery as though it were the only means of gathering information is ineffective in managing national security risk. Ultimately, the Committee is concerned that our failure to take a holistic view of these capabilities could create conditions that damage U.S. industry and U.S. security at the same time.

The Task Group's discussions with government officials about "modified operations" reflected an improved government understanding of the impact of such actions and the absolute need to limit the area and the time of such actions, consistent with a compelling national security case. Here the bar is set appropriately high: requests for such modified operations must be requested by the Secretary of State or the Secretary of Defense and made by the Secretary of Commerce. The Committee has offered to review specifically a set of criteria from the Department of Defense to U.S. combatant commands for initiation of modified operations. We strongly encourage the U.S. government to fully train and exercise around these ideas to understand the practical effects and outcomes.

But other ideas that the Task Group has heard – such as the creation of non-image/non-commercial sale "blackout" lists and technical downgrading of imagery – fail to recognize the significant economic and non-economic costs of regulation in a very competitive global environment. Finally, any regulatory action that looks like extensive "prior restraint" (more technically described as a "preempted commercial transaction") will likely require new legislative authority that inevitably would be challenged in court.

MOVING AHEAD

The Committee would be pleased to engage you and your staff on additional details not conveyed in this memorandum. Given the ACCRES meetings held to date, and the broad experience and perspective we bring, we can serve as a resource for the Department and others on the future of U.S. commercial remote sensing issues. We have asked NOAA to lay out a schedule for future meetings so that the Committee can organize our workload, including the role of public input within the spirit of the Federal Advisory Committee Act.

Consistent with the ACCRES Charter and the support of NOAA, the Committee proposes a number of short follow-on papers for your consideration:

-- **Why and How to Regulate**? We recognize that regulation exists to ensure compliance with U.S. law as well as foreign policy and national security objectives. Given the rapid shift away from an aerospace model to an information model, and given the reality of imagery as information, what are the purposes and parameters of regulation of commercial remote sensing companies? How can we reevaluate regulation of commercial remote sensing satellites to avoid unintended harm to U.S. foreign policy, national security, and economic interests? What areas beyond frequency allocation and orbital management require regulation, and why?

-- **NOAA internal review**: We wish to continue to help NOAA streamline their own internal licensing, license follow-up, compliance monitoring and enforcement activities, consistent with existing authorities. We do believe that NOAA has a number of existing authorities to do this. We also believe that there may be ways to facilitate licensing actions by creating templates for existing and new capabilities, such as the establishment of "safe harbor" provisions to protect past decisions.

--**Review of other U.S. government activities, including NSPD-27 review**: NOAA has requested that the Committee provide input on other U.S. government efforts regarding commercial remote sensing, including the proposed National Security Council review.

Points of contact: NOAA/NESDIS at NOAA and Chair, ACCRES.

Scott Pace

Dr. Scott Pace is the Director of the Space Policy Institute and a Professor of the Practice of International Affairs at George Washington University's Elliott School of International Affairs. He is also a member of the faculty of the Trachtenberg School of Public Policy and Public Administration. His research interests include civil, commercial, and national security space policy, and the management of technical innovation. From 2005-2008, he served as the Associate Administrator for Program Analysis and Evaluation at NASA.

Prior to NASA, Dr. Pace was the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). From 1993-2000, Dr. Pace worked for the RAND Corporation's Science and Technology Policy Institute (STPI). From 1990 to 1993, Dr. Pace served as the Deputy Director and Acting Director of the Office of Space Commerce, in the Office of the Deputy Secretary of the Department of Commerce. He received a Bachelor of Science degree in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989.

Dr. Pace received the NASA Outstanding Leadership Medal in 2008, the US Department of State's Group Superior Honor Award, *GPS Interagency Team*, in 2005, and the NASA Group Achievement Award, *Columbia Accident Rapid Reaction Team*, in 2004. He has been a member of the US Delegation to the World Radiocommunication Conferences in 1997, 2000, 2003, and 2007. He was also a member of the US Delegation to the Asia-Pacific Economic Cooperation Telecommunications Working Group, 1997-2000. More recently, he has served as a member of the U.S. Delegation to the UN Committee on the Peaceful Uses of Outer Space in 2009, and 20011-15. Dr. Pace has been a member of the NOAA Advisory Committee on Commercial Remote Sensing (ACCRES) since 2012. Dr. Pace is a former member of the Board of Trustees, Universities Space Research Association, a Member of the International Academy of Astronautics, an Associate Fellow of the American Institute of Aeronautics and Astronautics, and a member of the Board of Governors of the National Space Society.

Chairman BRIDENSTINE. Thank you, Dr. Pace. I'd like to now recognize Mr. Sternberg for five minutes.

TESTIMONY OF MR. SCOTT STERNBERG, PRESIDENT, VAISALA INC.

Mr. STERNBERG. Mr. Chairman, Ranking Member Bonamici, and the Members of the Subcommittee, thank you for the opportunity to speak with you today.

I am Scott Sternberg. I serve as the President of a company called Vaisala Inc. We're a global company of 1,600 professionals of which 450 are located here in the United States. We deliver weather observation product systems and services with a specific focus on scientific accuracy, precision, and reliability. And I think it's worth also noting that we focus on the ground-based segment of our observation networks.

I have basically three points that I'd like to make today: first, to share some real-world experiences regarding the provisioning of commercial weather data to the federal government, specifically in the context of the National Lightning Detection Network; second, to emphasize the importance of data quality for improved forecast; and finally, to stress the benefits of what I call contractual clarity.

At Vaisala we have an 80-year history in environmental sensing and data provisioning. One of Vaisala's first customers was MIT when in 1936 Vaisala delivered radiosondes, devices that are carried on weather balloons to measure the vertical atmosphere. Today, our sensors and technology are employed in many federal observation networks, including the Nexrad radar network, upper-air sounding stations, the ASOS platform along both the roadways and runways of America's transportation network and descending into severe storms to aid in the prediction of hurricanes. Our products and services enable our customers to better understand present, future, and to reduce uncertainty, but most importantly, it's to make informed decisions.

As a country, we're faced with the need to mitigate the impacts of extreme weather. This is demonstrated by Hurricane Sandy in 2012; the Colorado floods of 2013; the Moore, Oklahoma, tornado outbreak in the same year; and the Western drought, which is ongoing. These events alone are responsible for more than $70 billion in losses and over 190 fatalities.

A fundamental element of our ability to reduce impacts of severe weather is the availability and use of reliable and accurate weather data. Our success is dependent upon a balanced approach, which includes ground-based observations, aerial measurements, and satellite-derived data. To regain our preeminence in weather forecast, a subject that this Subcommittee has recently addressed with the Weather Research and Forecasting Innovation Act, we need concerted efforts from the entire weather enterprise, the public, private, and academic sectors.

One area where this has been demonstrated successfully is in lightning detection and lightning data delivery. Vaisala designed, deployed, owns, operates, and maintains the National Lightning Detection Network, or the NLDN. It's the longest continuously operating lightning network in the world. The NLDN has been providing precision real-time continental-scale lightning data since

1989 and continues to be the foundational data set for the federal government.

The NLDN successfully demonstrates how the private, academic, and government sectors came together to achieve a common goal. Today's NLDN represents countless contributions from each of the sectors over its 30-year history.

As a customer, the federal government uses NLDN raw data for inputs for severe weather forecasting. In addition, academic research uses the growing archive of the nearly 25 million cloud-to-ground lightning strikes that occur every year to better understand the role of atmospheric electricity in severe storms.

Much of the success of the lightning data model is based on a contractual arrangement that has created a balance wherein the federal government's use of lightning data is clearly defined, enabling Vaisala to successfully pursue lightning-related business in other markets. Through informed negotiation, internal controls, and appropriate data licensing and redistribution policies, the economic value of the commercial data is maintained while serving the public interest. This contractual clarity has allowed Vaisala to generate revenue that has in turn been reinvested to deliver continual improvements in the sensor technology and signal processing within the network.

Finally, rigorous quality control reinforced by scientific peer-reviewed validation studies assures users that they're receiving the highest-quality data available. This is vital not only due to the fact that the output of any numerical model strictly depends on the inputted raw data but also because lives and livelihoods are at stake.

The weather enterprise has changed substantially over the last few decades with the creation of over 350 U.S. commercial weather companies generating approximately $3 billion of revenue each year. In the right instances, the private sector should look to—the public sector should look to the private sector companies for products and services as a way to increase efficiency and effectiveness of their operations while at the same time reducing costs. However, as the NLDN has demonstrated, both the government and the private sectors need to recognize their mutual dependence on each other to move forward.

Thank you for this opportunity and I'd be willing to answer any questions.

[The prepared statement of Mr. Sternberg follows:]

Testimony of Mr. Scott Sternberg, President, Vaisala Inc.

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasting

Submitted to the

Subcommittee on Environment

Committee on Science, Space and Technology,

United States House of Representatives

20 May 2015

Good morning, my name is Scott Sternberg. I am the president of Vaisala Inc., Vaisala is a global company with over 1600 employees. We deliver weather observation products, systems and services, with particular focus on scientific accuracy, precision, and reliability.

I want to first start by thanking Chairman Bridentstine, Vice-Chair Westerman, Ranking Member Bonamici, and the rest of the members of the Subcommittee on Environment for the opportunity to speak to you today about commercial weather data and its relationship to improving weather forecasting. My goal is to share with you some real world experiences as they relate to the integration of commercial weather data into the weather forecasting business carried out in both the public and private sectors. Moreover, I would like to comment on the importance of data quality for improved forecasts. Finally, I would like to stress the benefits that contractual clarity can bring to the evolving weather enterprise.

Vaisala has a long history in environmental sensing and data provisioning spanning more than seven decades. One of Vaisala's first customers was the Massachusetts Institute of Technology. In 1936, Vaisala delivered radiosondes, a device carried on weather balloons to measure the vertical characteristics of the atmosphere, to MIT in support of atmospheric research being conducted by the institution. Since that time, Vaisala has introduced a number of advanced, innovative technologies and solutions aimed at enhancing our understanding of weather and climate, including, but not limited to, ground-breaking temperature, pressure, and humidity measurements, automated weather stations, sky condition sensors, weather radars, and lightning detection systems. Today, Vaisala sensors can even be found on the Mars Rover Curiosity, safeguarding the Mona Lisa, in the Louvre Museum, and descending into severe storms in support of the assessment and prediction of hurricanes in the Atlantic basin.

Over the years, Vaisala has become recognized as a global market leader in such areas as meteorological research and operations, transportation, energy, and defense industries. In addition, Vaisala provides environmental measurement and monitoring capabilities that support demanding industrial applications and the life sciences sector. Our aspirations can be summed up through one simple phrase, "observations for a better world." Through the use of our products and services our customers are able to better understand past, present and future environments, reduce uncertainty, and make well-informed decisions. In the United States, our top customers include the National Oceanic and Atmospheric Administration (NOAA), Federal Aviation Administration (FAA), State Departments of Transportation, and power utility companies.

Accordingly, the data generated by a wide variety of Vaisala systems serves as the raw input for both global and domestic forecast models.

As a country, we are currently faced with a number of challenges related to effectively mitigating the impacts of extreme weather. Some of these challenges are associated with the fact that the population of the country continues to steadily grow and its distribution is such that weather-related hazards can potentially have an increased impact. Moreover, our dependence on progressively complex, integrated networks and infrastructure (e.g. the transportation network and its operation) is placing more demand on the country's need to have effective, efficient weather and climate services that are second to none. This is clearly demonstrated by several events in our recent history including hurricane Sandy in 2012, the Colorado floods of 2013, the Moore, Oklahoma tornado during the same year, and the western drought, which is ongoing[1]. These events alone are responsible for more than 70 billion dollars in losses and over 190 fatalities.

> ***A fundamental element associated with our ability to reduce the impacts of these extreme weather events is the availability and use of reliable, accurate weather data that can be used for research, real-time weather analysis, and to drive the forecast models that we have come to depend upon. Most importantly, our success is dependent on a well-balanced approach that includes surface-based observations, aerial measurements, and satellite-derived data.***

In order for our nation to regain its preeminence in weather assessment and forecasting, it is going to require well-defined, concerted efforts from the entire weather enterprise, in other words, the public, private and academic sectors. Proper utilization of the pillars that make up the Enterprise will result in improvements in the effectiveness and efficiency associated with research and development, including research to operations, operational readiness and execution, and the timely delivery of accurate, reliable data and information to key decision-makers and stakeholders. Towards this end, NOAA has introduced the Weather-Ready Nation initiative and has recognized ambassadors such as Vaisala for their continuing contributions to improving our nation's resilience as it relates to mitigating the impacts of weather, water, and climate extremes. NOAA should be applauded for its efforts, as it has catalyzed a sense of urgency amongst the weather enterprise, while also convening a conversation about priorities and dependencies throughout the enterprise.

One important area where this has been demonstrated is in the area of lightning detection, and lightning data delivery. I would like to take a few minutes to share with you one example of how Vaisala has worked with the public and academic sectors to ensure the delivery of critical weather data for weather research and operations.

Vaisala designed, deployed, owns, operates and maintains the National Lightning Detection Network, also known as the NLDN. It is the longest continuously operating lightning network in the world. The network has been providing precision real-time continental-scale lightning data since 1989, and continues to be the foundational lightning dataset for the US Federal government. Lightning data from the NLDN is used by not only the National Weather Service

[1] https://www.ncdc.noaa.gov/billions/events

(NWS) but also the Federal Aviation Administration (FAA), Bureau of Land Management, National Aeronautics and Space Administration (NASA), the US Navy, the US Air Force and Army. Further, NLDN data is referenced in over 1000 scientific publications and serves as the definitive database for researchers and those in weather operations. The technology deployed in the NLDN has served as a template for numerous meteorological agencies around the world who, like the National Weather Service, continue to rely on high-quality observations for their meteorological operations.

The history of the NLDN is a powerful example of people and organizations in the private, academic and government sectors working together to achieve a common goal. The evolution of the NLDN from its inception to present day has been due to the efforts and dedication of numerous individuals and organizations. It involves too many contributions to reference in this testimony; however, I would like to specifically mention some key contributors such as the University of Arizona, the University of Florida, the National Severe Storms Forecast Center (NSSFC), the National Severe Storms Laboratory (NSSL), the Bureau of Land Management (BLM), the Office of the Federal Coordinator for Meteorology, State University of New York at Albany (SUNYA) and the Electric Power Research Institute (EPRI). These organizations saw the importance of the NLDN for both research and operational applications.

1983: The first NLDN lightning data recorded: a great achievement that demonstrates what scientific discovery, inter-organization cooperation and technology can achieve.

1987: The NASA Atlas/Centaur rocket was launched from Cape Canaveral Air Force Station in Florida, but within one minute after launch this unmanned rocket carrying a Pentagon satellite was struck by lightning and destroyed. After this incident NASA was able to secure financial support to receive real-time NLDN data.

1989: The NLDN provided complete coverage across the continental U.S.A. and with this expansion, real-time and historic NLDN lightning data were made commercially available. New application-specific software development began and customers in insurance, electric power, telecommunications and airports expanded their use of the NLDN data to validate claims, protect structures, airplanes, ground personnel, machinery, utility infrastructure and other lightning sensitive processes.

1992: A major technological improvement through a network-wide sensor and central processor upgrade was deployed. Better data quality increased the value of the NLDN to the Electric Power Research Institute (EPRI) and to the electric power industry as a whole and in the same year, the National Weather Service (NWS) signed an agreement to receive NLDN data. The data proved to be an integral part of the NWS's mission to provide weather forecasts and warnings to protect life and property.

1998: The Canadian Lightning Detection Network was seamlessly integrated with the NLDN, which benefited Canadian and American meteorologists with better visibility of severe storms and exchange of weather data. The combined networks today make up the North American Lightning Detection Network.

Over 30 years there have been numerous upgrades to the technology deployed in the NLDN. Sensor technology advancements and central processing innovation has delivered constant improvements in performance (detection efficiency, location accuracy, and characterization) with rigorous quality control reinforced by scientific peer review to assure users that they are receiving the highest quality data available.

The latest sensor upgrade to the network came in 2013 when we deployed the LS7002 Advanced Total Lightning sensors providing the federal government and other Vaisala customers with a more comprehensive view of lightning activity across the USA. The location accuracy of the NLDN improved to about 150 m in the interior of the network, and lightning counts grew significantly with the availability of total lightning.

The Vaisala and NOAA relationship continues today with Vaisala supplying real-time data feeds of NLDN and GLD360, Vaisala's long-range global lightning dataset, which is distributed to over 100 regional Weather Forecast Offices across the U.S. As a data customer, the Federal Government ingests raw data that is used as input for severe weather warnings and forecasting. Further, the ever growing archive of the nearly 25 million lightning cloud-to-ground strikes occurring every year is routinely used in research and forensic studies to better understand the role of atmospheric electricity in severe storms.

Much of the success of this lightning data delivery model is based on the contractual arrangement that has created a balance where the Federal government's usage and application of the lightning data is clearly defined, enabling Vaisala to successfully pursue lightning related business in other sectors, as well as outside of the United States. This has allowed Vaisala to generate revenue from other customers and markets that rely on lightning data. Accordingly, financial resources become available to be reinvested to improve the technology and its performance, improvements that the federal government has been able to share.

These performance improvements include uniformity of detection across CONUS, detection efficiency, location accuracy, and Advanced Total Lightning, all characteristics of lightning detection performance that the federal government values. This state-of-the-art data results in improved information for forecasting and supports better understanding of severe weather, establishing a win-win situation for all parties involved.

It is important to understand the Weather Enterprise has changed substantially over the last few decades, with a significant growth in private sector companies across the United States. Recent statistics suggest that over 350 U.S. commercial weather companies generate approximately $3 billion dollars a year in revenue[2]. Many of these companies, including Vaisala, have a strong capacity to create new, innovative products and services for weather-sensitive sectors. This includes the production and management of novel datasets, advanced forecasting techniques, and applications to support critical, weather-based decision making.

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[2] http://knowledge.wharton.upenn.edu/article/todays-forecast-for-the-weather-business-increased-revenues-and-a-focus-on-innovation/

> ***Vaisala takes approximately 10% of its annual net sales, or roughly $30 - 35 million dollars and invests in research and development activities, enabling new and improved technologies, services and applications. Due to the maturation of the private sector, including the investments made in research, development, and operations, it is no longer necessary for the public sector to assume the entire burden of the end-to-end process related to the production and dissemination of weather data and information.***

In the right instances, the public sector should look to private sector companies for products and services as a way to increase efficiency and effectiveness of their operations, while reducing costs. The provisioning of commercial weather data is one clear area of opportunity.

> ***While the commercial sector is poised to provide data and services that would support the mission of weather-related agencies such as NOAA, it is imperative that the Federal Government and other organizations obtain data that is proven to be accurate, precise, and reliable. This is vital since accurate, timely assessment of the atmosphere is at the foundation of weather analysis and forecasting.***

This can be accomplished through many means. For example, only acquiring data that has been thoroughly assessed and verified, as evident from peer-reviewed scientific literature, or working with potential data providers to establish a verification campaign before entering into a binding contract, or using a third-party to conduct verification studies on the data prior to acquisition.

The benefits of obtaining commercial weather data for use in federal operations can be great. In many cases it may be possible to reduce the total cost of ownership compared to the traditional approach of procurement deployment, operation and maintenance of infrastructure. However, both the government and private sector need to recognize their mutual dependence on each other.

> ***Through proper contractual language, internal controls and appropriate data licensing and redistribution policies, the economic value of commercial data can be maintained while simultaneously serving as an important input to federal operations. Furthermore, as the concept of commercial data buys matures, the clarity of roles and responsibilities of the public, academic and private sectors becomes clearer. Through this balanced understanding it then becomes possible to create a symbiotic development environment that focuses on the sustainable evolution of the ecosystem that is the weather enterprise.***

Thank you very much for the opportunity to present this testimony. I would be happy to answer any questions or provide more information at your convenience.

VAISALA

Scott J. Sternberg
President, Vaisala Inc.

Biographical Information:

Scott Sternberg serves as President of Vaisala Inc., Vaisala's US subsidiary. Vaisala is a leading manufacturer of professional weather and controlled environment systems and solutions. Scott is responsible for the regional governance of Vaisala's US-based operations.

Scott has held the position of Executive Vice President of Service where he was responsible for the consolidation of Vaisala's global customer service functions. In this capacity Scott served as an expatriate on assignment from 2007 to 2009 at Vaisala headquarters in Finland. Scott joined Vaisala in 2004 as the Strategic Business Unit Manager for Vaisala's Thunderstorm Data unit based in Tucson, Arizona U.S.A. where he managed the data products generated from the National Lightning Detection Network (NLDN).

Prior to joining Vaisala, Scott held a number of positions ranging from product management to business development for Roper Industries-Photometrics. Here he specialized in providing advanced digital imaging solutions to scientific applications.

In addition to his Vaisala responsibilities, Scott serves on the Board of Trustees for the University Corporation for Atmospheric Research (UCAR) and as Chairman of the Board of Directors for CO-LABS.

Scott holds both a BS and MS in Physics from SUNY, College at Cortland and Colorado State University respectively.

Chairman BRIDENSTINE. Thank you for your testimony.
I'd like to now recognize Ms. Robinson for five minutes.

TESTIMONY OF MS. NICOLE ROBINSON,
CHAIR, HOSTED PAYLOAD ALLIANCE

Ms. ROBINSON. Thank you. Chairman Bridenstine, Ranking Member Bonamici, and members of the committee, as Chair of the Hosted Payload Alliance, it's my honor to participate in today's proceedings while representing our diverse and accomplished group of Hosted Payload Alliance members. I was pleased to submit to the committee my written testimony, as well as the database of current commercially hosted government payloads on contract today, and I thank you for the opportunity to offer these brief summarized remarks.

During your February hearing on America's weather satellites in weather forecasting, Chairman Bridenstine, you urged that we should "look to augment our satellite systems through commercial means, just as the Department of Defense and NASA have done," and "we must look outside the box for new methods of providing essential weather data." The Hosted Payload Alliance has heard your call for commercial integration and stands ready to assist and enable NOAA efforts to incorporate new and responsive acquisition practices to further weather-sensing capabilities.

The Hosted Payload Alliance, already with a history of demonstrated success on orbit, and with other payloads on contract, is ready to institutionalize this "out-of-the-box" approach. This hearing helps that effort.

A hosted payload is a portion of a satellite, such as a sensor, instrument, or a set of communication transponders that are owned by an organization or agency other than that of the primary satellite operator. The hosted portion of the satellite operates independent of the main spacecraft but shares the satellite's power supply, transponders, and in some cases, the ground systems.

The concept of a hosted payload is not entirely new, as many U.S. Government-designed and built satellites have for years been developed with hosting in mind. However, what is relatively new is the concept of using commercially available space, weight, and power to host government-developed payloads, instruments, or transponders. Commercially hosted payloads enable government organizations to make use of a commercial satellite platform in order to save costs and create a more distributed architecture for space assets.

Choosing, in essence, to piggyback a hosted payload on a commercial satellite has many benefits. I'll summarize here, and my written statement provides additional depth into each of these sections.

Shorter time to space. Roughly 20 commercial satellites are launched to geosynchronous Earth orbit each year. Each one presents an opportunity to add additional capability.

Lower cost. Placing a hosted payload on a commercial satellite costs a fraction of the amount of building, launching, and operating an entire satellite by itself.

A more resilient architecture. Posted payloads enable more resilient space architecture by distributing assets over multiple platforms and locations.

Increased access to space. With roughly five satellite launches every quarter, the commercial satellite industry provides a multitude of opportunities for frequent access to orbit.

Operational options. Hosted payloads have multiple options to use existing satellite operations facilities with shared command and control of the hosted payload through the life of the host satellite, or a completely dedicated and separate system operated by the hosted payload owner.

NOAA has stated their goal of future architecture is to "evolve to a more responsive architecture that leverages a suite of capabilities including rapid, less costly missions and direct purchases of services and data to ensure long-term economic viability." Using hosted payloads on commercial satellites is a pivotal tool for the government and NOAA specifically to leverage emerging technologies to gain affordable access to additional space capabilities and critical enablers in constrained fiscal environment.

The hosted payload model has clearly demonstrated the timeliness, responsiveness, and cost efficiency of integration between the government and commercial industry. Pointing to a couple of examples, with the Commercially Hosted Infrared Payload program, known as CHIRP, a successful DOD program that achieved its objective in an initiative that provide capability for an estimated 15 percent of the cost to build, launch, and operate a comparable DOD satellite.

In another real-world example, a hosted payload has saved the Australian Defense Force on the order of $150 million in satellite communication costs versus traditional, monolithic acquisition practices. In the civilian applications arena, multiple Wide Area Augmentation System, or WAAS-hosted payloads, have enabled the FAA to achieve enhanced GPS accuracy for safer and more efficient air traffic control.

Finally, the members of the Hosted Payload Alliance value the opportunity to promote the values of our alliance to the Subcommittee. We appreciate your most recent legislative support, H.R. 1561, voted out of the House just last night. The language supporting consideration of hosted payloads is significant and we're thankful for your continued support of our collective effort to contribute. Thank you.

[The prepared statement of Ms. Robinson follows:]

WRITTEN STATEMENT BY
NICOLE ROBINSON
CHAIR, HOSTED PAYLOAD ALLIANCE

HEARING ON
ADVANCING COMMERCIAL WEATHER DATA:
COLLABORATIVE EFFORTS TO IMPROVE FORECASTS

BEFORE THE
SUBCOMMITTEE ON ENVIRONMENT
U.S HOUSE OF REPRESENTATIVES

May 20, 2015

Chairman Bridenstine, Ranking Member Bonamici and Members of the Committee, as Chair of the Hosted Payload Alliance, it is my honor to participate in today's proceedings while representing our diverse and accomplished group of Hosted Payload Alliance members. I'm pleased to join Professor Scott Pace from George Washington University's Elliott School of International Affairs, Scott Sternberg, President of Vaisala Inc, Dr. Bill Gail of Global Weather Corporation and Dr. Thomas Bogdan of the University Corporation for Atmospheric Research at today's hearing.

During your February hearing on "Bridging the Gap: America's Weather Satellites and Weather Forecasting" Chairman Bridenstine urged that, "...we should look to augment our satellite systems through commercial means, just as the Department of Defense and NASA have done" and "...we must look outside the box for new methods of providing essential weather data." The Hosted Payload Alliance (HPA) has heard your call for commercial integration and stands ready to assist and enable the National Oceanic and Atmospheric Administration (NOAA) effort to incorporate new and responsive acquisition practices to further weather sensing capabilities. The Hosted Payload Alliance, already with a history of demonstrated success on orbit, and with others payloads on contract, is ready to institutionalize this "out of the box" approach. This hearing helps in that effort.

Established in 2011, the Hosted Payload Alliance is a satellite industry group whose purpose is to increase awareness of the benefits of hosted government payloads on commercial satellites. The HPA is a non-profit association of seventeen diverse space industry members with broad expertise established to serve as a bridge between government and private industry to foster open communication between potential users and providers of hosted payload capabilities. The focus of the Alliance is on education, awareness and developing solutions to common hosted payload challenges.

A hosted payload is a portion of a satellite, such as a sensor, instrument or a set of communications transponders that are owned by an organization or agency other than the primary satellite operator. The hosted portion of the satellite operates independently of the main spacecraft, but shares the satellite's power supply, transponders, and in some cases, ground systems. The concept of a hosted payload is not entirely new, as many USG designed and built satellites have for years been developed with "hosting" in mind; however, what is relatively new is the concept of using commercially available space, weight and power to host government-developed payloads, instruments, or transponders. Commercially hosted payloads enable government organizations to make use of commercial satellite platforms in order to save costs and create a more distributed architecture for space assets.

Choosing, in essence, to piggyback a hosted payload on a commercial satellite has many benefits:

Shorter time to space. Because the development of an entire satellite system is not required, a hosted payload on a commercial satellite can reach space in a fraction of the time that it would take to develop a

free flyer program. Roughly 20 commercial satellites are launched to geosynchronous earth orbit each year and each one presents an opportunity to add on additional capability.

Lower cost. Placing a hosted payload on a commercial satellite costs a fraction of the amount of building, launching and operating an entire satellite. Cost reductions can result from shared integration, launch and operations with the host satellite.

A more resilient architecture. Hosted payloads enable a more resilient space architecture by distributing assets over multiple platforms and locations. Rather than creating a single platform with multiple capabilities that could be a target for adversaries, spreading capabilities over multiple locations has the potential to contribute to a disaggregated and resilient space architecture.

Increased access to space. With roughly 5 satellite launches every quarter, the commercial satellite industry provides a multitude of opportunities for frequent access to orbit..

Operational options. Hosted payloads have multiple options to use existing satellite operations facilities with shared command and control of the hosted payload through the host satellite, or a completely dedicated and separate system operated by the hosted payload owner. For sensitive payloads, the government can even chose dedicated and highly encrypted communications downlinks as DoD has with its early hosted payloads.

NOAA stated in their "Next Generation Satellite – Plan" briefing, presented by Thomas Burns, Deputy Assistant Administrator for Systems, on April 28, 2015 that their goal of future architecture is to, "evolve to a more responsive architecture that leverages a suite of capabilities including rapid, less costly missions and direct purchases of services and data to ensure long term economic viability." Using hosted payloads on commercial satellites is a pivotal tool for the government, and NOAA specifically, to leverage emerging technologies to gain affordable access to additional space capabilities, critical enablers in our constrained fiscal environment. The hosted payload model has clearly demonstrated the timeliness, responsiveness and cost-efficiency of integration between the government and commercial industry via the Commercially Hosted Infrared Payload – a successful DoD program that achieved its objectives in an initiative that provided capability for an estimated 15% of the cost to build, launch and operate a dedicated military spacecraft. In another real-world example, a hosted payload has saved the Australian Defense Force over $150M in satellite communications costs versus traditional, monolithic acquisition processes, and multiple Wide Area Augmentation System hosted payloads have enabled the FAA to achieve enhanced GPS accuracy for a safer and more efficient air traffic control system. Our Alliance is poised to continue our relationship with NOAA to help achieve greater successes in the future.

Finally, the members of the Hosted Payload Alliance value the opportunity to promote the values of our Alliance to the Subcommittee. We certainly appreciate the continued Congressional support of our collective effort to contribute to and enable NOAA's, and other government agencies', critical satellite-enabled missions.

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Nicole Robinson

Chair, Hosted Payload Alliance

Nicole Robinson joined SES Government Solutions in 2007 and currently serves as the Corporate Vice President of Government Market Solutions. In this position, she is responsible for the development of new products, go-to-market strategies and new business opportunities with global governments and institutions.

Ms. Robinson is currently serving in the elected position of Chair of the Hosted Payload Alliance, serves on the Board of the Washington Space Business Roundtable (WSBR) and was the recipient of a 2012 Future Leaders Award by the Society of Satellite Professionals International.

She has spent 15 years in the Defense industry, with a Bachelor's in Communications, an MBA from Liberty University and is a graduate of the Senior Executives in National and International Security Program at Harvard University, Kennedy School of Government.

Chairman BRIDENSTINE. Thank you, Ms. Robinson.
Dr. Gail, you're recognized for five minutes.

TESTIMONY OF DR. BILL GAIL, CHIEF TECHNOLOGY OFFICER, GLOBAL WEATHER CORPORATION

Dr. GAIL. Chairman Bridenstine, Ranking Member Bonamici, and distinguished Members of the Subcommittee, it's a privilege to be here testifying today. I will be speaking to you from my personal perspective but I wear two hats: first, as a voice of the weather community in my role as past President of the American Meteorological Society, and second, as a member of that community building my own startup company, Global Weather Corporation.

Let me first commend you for the attention you're giving to the broad topic of NOAA data sources and particularly the role of commercial satellite data. Through the satellite data issue is itself important, you have been wise to broaden the discussion. The reason is that the world moves ever more rapidly around us. Weather is quickly becoming part of the emerging information economy. The services we provide will need to change. They will become more highly customized matched to each user's needs, and delivered when and where users need it. We will no longer produce one forecast for the entire United States but instead one or more for each individual business.

Now, what does this mean for NOAA's data sources? Picture a train headed down the tracks. This train represents all of the data sources from satellites to balloons, which NOAA presently uses to monitor weather and run forecast models. Now imagine a second train that is rapidly catching the first traveling on a recently laid parallel track. It represents the emerging breed of external data sources epitomized by the Googles of the world, as well as innovative providers within our weather field.

Such new data is vast and daunting, weather observations from automobiles, mobile phones, social networks, and a myriad of other sources never before available. Like it or not, these parallel tracks cannot remain separate for long. They inevitably reach a junction. The trains will collide or, through a bit of effort on the part of NOAA, they could be hitched together instead. Successfully hitching them would ensure NOAA of the ongoing value of its traditional data and leverage the vast amount of new weather-related data from emerging sources.

Now, how do these trains get hitched? I believe NOAA already has the means. On its output side, NOAA has long relied on an elaborate services ecosystem. It is built on partnerships ranging from emergency managers to commercial companies. These partners extend NOAA's data and provide value-added services to end-users all at no cost to NOAA. This has been highly successful and is the envy of the world. It is estimated that nearly 90 percent of the weather information reaching the public is supplied through this ecosystem rather than directly by NOAA.

Now, when it comes to the input side—in other words, data used by NOAA—the ecosystem is much less mature. My recommendation is that NOAA should focus on raising the data ecosystem to a level of maturity comparable to its highly successful services ecosystem. Through such an ecosystem, NOAA could extend the

breadth and depth of the data they acquire even within limited budgets as costs are often shared by others. Such a data ecosystem would promote desirable characteristics of flexibility and robustness, enhancing NOAA's resilience to data loss scenarios and improving its technical performance.

Now, building this data ecosystem raises many practical issues. You've seen this with the issue of commercial satellite sounding data before this Subcommittee. My written testimony describes many of the challenges and suggests some solutions. Among them is the challenge of protecting our core principle of open data. It has served this community well but needs to be extended so that important data sources are not made inaccessible. Resolving it properly is also critical to our international partners and to ensuring continuity of the data we receive from them.

Succeeding with this vision will require innovation and partnerships as much as in technology. Our two trains will not hitch properly if we rely only on traditional mechanisms such as data buys. The new information world is characterized by business relationships that were unheard of when the data buy paradigm was first developed. NOAA has excellent experience creating innovative partnerships on the services side such as through their Weather-Ready Nation Initiative. It should seek to do so on the data side as well.

Weather legislation isn't considered within Congress often. In deliberating the evolution of data sources used by NOAA, I urge you to take a decadal-scale view. The legislation you pass needs to stay relevant despite the enormous advances expected within information technology over that timescale. In this context, providing NOAA with the resources needed to develop a true data ecosystem will pay off to the nation many times over. Thank you.

[The prepared statement of Dr. Gail follows:]

WRITTEN STATEMENT OF

William B. Gail, PhD
Co-founder and Chief Technology Officer, Global Weather Corporation (GWC)
Past-President, American Meteorological Society (AMS)

Before the
Subcommittee on Environment
Committee on Science, Space, and Technology
United States House of Representatives

A Hearing on: ***Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts***

20 May 2015

Chairman Bridenstine, Ranking Member Bonamici, and distinguished members of the Subcommittee: It is a privilege for me to be present here today and provide testimony to you. Thank you for your invitation. My name is Bill Gail. I am co-founder and Chief Technology Officer of Global Weather Corporation, a provider of precision weather forecasts to businesses within the energy, media, transportation, and consumer sectors. I am also Past-President of the American Meteorological Society (AMS). I am a member of the newly formed Department of Commerce Data Advisory Council (CDAC) charged with recommending means for expanding the public value of Commerce data such as NOAA's, and was also a member of the National Research Council committee that authored the 2012 study *Weather Services for the Nation: Becoming Second to None*. My academic training is in physics and electrical engineering and I have nearly two decades of experience in the fields of meteorology satellites, weather services, and location-aware software.

Though I'm speaking to you today from my personal perspective, I wear two hats: first as a voice of the weather community through my AMS position, and second as a member of that community building my own startup company. My company has been successful in today's difficult economy precisely because high quality weather information is increasingly needed by businesses across many industries to serve their customers and improve operations.

Let me first commend you for the attention you are giving to the topic of commercial weather data availability, and particularly the controversial role of commercial satellite data. This Subcommittee has raised specific issues about use of commercial satellite data, and now broader questions about NOAA data in general. Though the question of commercial satellite data is itself important, I believe you have been wise to broaden the topic. Addressing these more general issues is critical to NOAA's ongoing success and its future progress.

SUMMARY OF TESTIMONY: A DATA ECOSYSTEM STRATEGY FOR NOAA

In this testimony, I will recommend that NOAA place increased emphasis on the breadth and depth of the data they acquire. This, I believe, is in keeping with both the Subcommittee's objectives and NOAA's goals of enhancing their services. NOAA has long relied on an elaborate NOAA *services ecosystem*, built on partnerships ranging from emergency managers to commercial companies. These partners extend NOAA's data and provide value-added services to end-users. This approach has been highly successful and is the envy of the world.

When it comes to data used by NOAA, however, the ecosystem is much less mature. *The objective of this testimony is to suggest a rationale and approach for creating a NOAA data ecosystem comparable in value to NOAA's highly successful services ecosystem. Such a data ecosystem would promote desirable characteristics of flexibility and robustness, enhancing NOAA's resilience to data loss scenarios and improving its technical performance.*

KEEPING OUR EYE ON THE OBJECTIVE

I want to make clear that *the end goal of all we do is serve the public*, not our institutions. All we do should be measured by that metric. Enhancing the role of the commercial sector is a worthy objective to the extent that it serves this goal. But any change in NOAA data policies or processes must recognize two critical considerations:

- *Weather is global.* Tomorrow's weather here in Washington, DC may have originated last week in patterns over Siberia. We need data from other nations to forecast our weather as much as they need our data to forecast theirs. Historically, this has been accomplished by international agreements enabling free and open sharing of data. This core principle has proven enormously successful. Should we seek changes, such as an increased role for commercial data, this must be viewed in the international context.

- *NOAA is the world's gold standard.* Despite widely discussed weaknesses in some limited areas, NOAA's overall program is still the envy of the world. While we should seek to improve NOAA, we must be very careful not to break what is working well, including the system of satellite data acquisition. During the 1990's modernization, the National Weather Service, as directed by Congress, employed a principle known as "no degradation of services"[1] to guide and monitor all changes made to the system. This was a wise principle then, and should be used to informally guide future changes.

We must keep these considerations in our minds as we proceed through the discussion.

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[1] U.S. Congress. 1992. National Oceanic and Atmospheric Administration Authorization Act of 1992. Public Law 102-567, Sections 701-709.

COMING SOON: WEATHER FOR EVERY NEED, TIME, AND PLACE

Those of us involved in delivering weather services are confronted daily with the demand for new and different weather use cases. Part of this demand is driven by the rapid adoption of mobile phones, through which businesses and consumers can consume weather in new ways. Part of it is the ease of customizing and delivering weather information to meet these needs, given progress in web services and such things as cloud computing. The broader information world, epitomized by Silicon Valley startups and venture capital backing, gets this growing market demand. I know. In my role leading a startup weather company, I talk to many of these new-technology companies and hear about their needs. Who, a decade ago, would have imagined high-performance sports clothing that anticipates and adjusts to the weather?

The emerging information economy is the context for this change. The number of people throughout the world with access to quality weather information will increase by an order of magnitude in the next decade. Smart phones make that possible. Even those of us with such access already will find we are using weather information perhaps two orders of magnitude more often, as it becomes embedded in apps and smart devices in ways we may never even notice. The information required will have to be highly customized, matched to each user's needs, and delivered when and where they need it. We will no longer produce one forecast for the entire U.S., but instead one for each individual, and perhaps several for each business.

We are undergoing a revolution in weather usage, driven by the context of the world around us. One consequence is that NOAA requires significant advances in the breadth and type of data sources available to them.

THE LOOMING INFORMATION COLLISION

What does this mean for NOAA's data sources? Picture *a train headed down the tracks*. This train represents all of the present data sources – from satellites to balloons – through which NOAA[2] monitors weather and drives our forecast models. The train is now decades old, having been refurbished many times to keep it operating well.

Now imagine a *second train* is rapidly catching the first, travelling on a parallel track that was only recently laid. It represents an emerging breed of data producers, epitomized by the Googles and Microsofts of the world, as well as innovative providers more closely aligned with the weather field. Included are weather observations from automobiles, mobile phones, social networks, and a myriad of other sources never before available. It also reflects the rapidly growing volume of more traditional weather observations from non-NOAA sources such as

[2] Accompanied by many of us in other academic, public, and private organizations, all part of what is referred to as the weather, water, and climate *enterprise*.

mesonets and aircraft, which are still not being effectively integrated into the NOAA data architecture.

The future is not hard to foresee. Like it or not, these parallel tracks cannot remain separate for long. Indeed, we might picture a junction at which the trains will arrive in the near future. The trains can either collide, or with a bit of effort on the part of NOAA, hitch together. Hitching trains in no way means the "new data sources" necessarily replace the old. It does mean the old and new have to coexist, and ideally strengthen each other, in ways they currently don't.

NOAA IN THIS NEW INFORMATION WORLD

This situation is not unique to NOAA. It is something being faced by the weather community internationally, and certainly by many communities beyond ours. The particular issue that has been discussed extensively within this Subcommittee, NOAA's potential use of commercial satellite data, is but one element of this much larger data source transformation. It is a disruptive transformation, not one readily understood and accommodated.

But picture a world in which NOAA does not effectively hitch trains. A future Congress will be holding hearings such as this asking why substantial sources of information about the weather are not used at all in NOAA's weather models. Perhaps some large company will take on this task themselves, combining their data with NOAA's own free and open data to produce forecasts far more accurate than NOAA can. These commercial forecasts would perhaps not themselves be available free and open to the public.

NOAA's new information world will be characterized by data sources far more numerous and diverse than today. Some are very similar to its present sources, derived from government-owned sensors and systems built to NOAA specifications. At the other end of the spectrum is entirely ad hoc data, such as from Twitter. It may come and go in hard-to-anticipate ways, yet is still very valuable. Diversity of data sources is not entirely unfamiliar to NOAA, which already relies heavily on volunteer observer networks, for example. Over the past decade, NOAA has also greatly improved its ability to assimilate data from NASA's scientific satellites.

Why are these new data sources so important to NOAA? In our ongoing efforts to improve forecast skill, new data sources are the raw material we can't do without. They play many different roles:

- *Expanding data sources for NWP[3] assimilation.* NWP models are only as good as the data they assimilate. At some point, additional computing power cannot advance NWP

[3] Numerical Weather Prediction (NWP) models are the workhorses of weather forecasting. They replicate the present state and evolution of the atmosphere at regional and global scales. Human forecasters use them as

forecast skill without additional data at finer spatial and temporal scales. New data is essential, though it must be matched to progress in computing power, model resolution, and underlying model physics.

- *Validating NWP performance.* Assessing performance of NWP models at improved space and time resolutions requires increasingly fine-scale data. This is unlikely to be obtained entirely through traditional processes, such as building more NOAA-quality weather stations. Non-traditional data sources can contribute substantially.

- *Countering NWP latency.* A significant NWP weakness is the latency between data acquisition and forecast release time, resulting from the computational time of the model. Techniques such as post-processing[4], which rely heavily on observations, can be used to counter this latency by adjusting NWP output in near real-time to more closely match current observations.

- *Improving the initial analysis.* The initial analysis is the estimate of current conditions throughout the atmosphere, and it is the starting point for all numerical weather predictions. We are presently limited in our efforts to improve this by lack of observations. Improving accuracy and completeness of the analysis field is a primary driver for improving forecast skill at regional and global scales. A greater spatial density of observations, such as temperature and pressure, would improve the initial analysis.

- *Improving mesoscale severe weather forecasts.* Severe weather at regional and local scales, such as tornado formation and coastal storms, can be strongly impacted by highly localized phenomena. A greater spatial density of observations, such as surface temperature and pressure from mobile phones or vehicles, can improve forecasts for these events. Increased spatial and temporal density for upper atmosphere measurements is highly desired, though less addressable as a byproduct of consumer technologies.

- *Improving underlying climatology.* Climatology models – estimates of the normal spatial variability of weather conditions – are used for downscaling forecasts. Since forecasts are generally made using grid cell sizes larger than the variability of weather activity, downscaling based on climatology is used to estimate what is happening at finer scales. Finer scale observations would improve climatology models.

"guidance" to create a final forecast, but their increasing accuracy means they are used more and more as the accepted forecast without further human modification, especially beyond the one-day forecast.

[4] One example is the technique known as Model Output Statistics (MOS), which has been used for many years to improve forecast accuracy of critical variables such as temperature by about 20% at sensor locations (such as at airports). The National Weather Service employs MOS-based models.

- *Improving application-specific forecasts.* Increasingly, end-users demand forecasts specific to their needs, not simply a generic weather forecast. Wind energy suppliers, for example, need to know wind speed at the 80-100 meter height of wind turbines. This can be substantially different than the wind speed at ground level. Commercial vehicles need to know the exact weather conditions along every road segment, not an average. Knowing that the average condition of a road is dry does not help when there are icy patches.

Society's demands for these high-fidelity forecast improvements are growing. The financial benefits of addressing such improvements are increasingly clear. I prefer to picture NOAA as the leader in this data integration, not a follower. It is an inevitable future. If not NOAA, then it will be someone else. The lessons being learned from today's commercial satellite discussions, particularly regarding radio occultation data, are central to starting this process. We should not look back at why these discussions have been contentious, but look forward at what is possible for NOAA, and for the nation we all serve, by exploring the bigger picture.

CASE STUDIES

Though this vision addresses the future, the issues involved with its implementation are very much present today. Following are four examples of data sources that illustrate both the challenges and the opportunities faced by NOAA today:

- *Satellite temperature and water vapor sounding data.* Satellite sounding data is among the highest value data for improving forecast quality. This Subcommittee has already specifically addressed the potential for NOAA to purchase commercial sounding observations. Such observations have been proposed using both geostationary optical imagers and radio occultation satellites. H.R. 1561 includes provisions for pursuing these interests. However, a more developed and ready program, COSMIC-2, potentially provides a near-term source for valuable radio occultation data. This program, funded largely by Taiwan in cooperation with NOAA and the U.S. Air Force, builds upon the highly cost effective COSMIC program that is already providing data used by NOAA and major weather centers throughout the world. A number of key lessons have emerged from this discussion already:

    - *Cost/benefit/risk of new data and systems.* Evaluating the cost, benefit, and risk of proposed systems (in contrast to doing so for existing data sources) is a critical element of building a robust ecosystem, particularly if NOAA resources contribute to development of the source. Often, seemingly small distinctions such as calibration quality can have major impact on the value of an approach. Such assessments need to be done fully and carefully prior to acquisition decisions.

- *Roles of government and commercial data.* My opinion is that COSMIC-2 is a sound program, of good financial value to NOAA, and should be completed without risk from commercial substitutions. Yet robustness of data sources is valuable to NOAA. To the extent that proposed commercial sources provide redundancy or augment COSMIC-2 with additional data, and to the extent they promote emergence of robust commercial data, they are quite valuable and should be promoted. At minimum, a system capable of replacing COSMIC-2 data after its lifetime must be planned, and commercial sources present an excellent option.

- *Challenges around open data policies.* Open data policies may limit the business case options for commercial sounding providers and thus preclude such data from even coming available. This illustrates a clear conflict between two desirable goals: a) maintain open data for the benefit of the entire community, and b) promote the emergence of commercial data sources that can benefit the weather community and the public. The resolution of this conflict is not simple, with strong disagreement even about whether such data is defined as falling under the domain of data that should be free and open or not. We need thoughtful evolution of currently policies to resolve this, which should be accomplished within the context of the World Meteorological Organization (WMO).

- *Opportunity versus threat.* Commercial proposals such as those that have been put forth in this area reflect substantial initiative and risk-taking on behalf of the companies and their investors. Such initiative is often the seed of breakthroughs that take our field to new levels. New ideas always bring challenges that must be worked through to determine if the ideas are worthy or not. NOAA should embrace this business innovation process and the new ideas it produces. Issues associated with proposed opportunities should be worked out through open community dialogue with the proposers, along the lines recommended in the 2003 National Research Council report *Fair Weather: Effective Partnership in Weather and Climate Services*. All parties are best served when proposers offer credible plans that can be properly evaluated and seek community dialogue as the primary means for promoting their initiatives, though the need to protect competitive information should be respected.

- *Aircraft flight observations data.* Aircraft flight data is also among the highest value data for improving forecast quality. NOAA currently purchases data from U.S. carrier long haul flights (known as AMDAR[5]) through a commercial aggregator. The data is

[5] AMDAR is the acronym for Airborne Meteorological DAta Reporting. TAMDAR is the acronym for Tropospheric Airborne Meteorological DAta Reporting.

redistributed largely free and open to other international meteorological agencies but not to other parties. NOAA receives equivalent data from Europe and other partners. Aviation weather data from regional flights (known as TAMDAR), which provide more detail on the lower atmosphere, are also commercially available. Unlike AMDAR, they are sold commercially to meteorological agencies separately on a non-open basis. NOAA is not presently purchasing this data, while other agencies are. As presently configured, many airlines do not participate. For those that do, the partner relationships are fragile and there is risk of losing these data sources.

- *Surface observations data.* NOAA has an established network of more than 900 surface observations stations known as the Automated Surface Observation System (ASOS), deployed largely during the 1990's. Other nations have equivalent systems. Data are freely available for all users, with some technological limitations. Over recent years, both commercial and academic institutions have deployed additional networks[6]. Today, there are perhaps 50,000 surface observation stations of varying quality throughout the world, some with open data policies and some not. Yet NOAA uses few of these observations today.

- *Vehicle observations data.* Vehicle observations are an example of a non-traditional data source that could be used by NOAA and other meteorological agencies. With millions of vehicles travelling at any given time even within the U.S., the number of potential observation locations is orders of magnitude larger than traditional ground observation stations. There is some research suggesting vehicle data, through its fine spatial density, can improve near-term severe weather forecasts such as for tornadoes.

Each of these case studies provides different lessons for a NOAA data ecosystem. Understanding the lessons is essential to building a robust ecosystem.

EXTENDING NOAA'S DATA ECOSYSTEM

The U.S. weather enterprise has been built upon the concept of NOAA providing data, from observations to model output, free and open for use by others. The result has been an enormous ecosystem of value-added providers and researchers who themselves further the public benefit. Today, it is estimated that more than 90% of weather information reaching the public passes through this value-added process, most of which is commercial. Other nations and world regions

[6] A 2008 National Research Council study titled *Observing Weather and Climate From the Ground Up: A Nationwide Network of Networks* discussed the emergence of networks of ground-based observing stations, established by businesses, state and local governments, and even individuals. Some are research networks, some commercial, and some consumer. The report recommended, and the community has struggled to implement, aggregating these individual networks through a national-scale system that makes the data readily accessible.

approach this differently, with less reliance on value-added partners. As a result, the U.S. has the most vibrant and productive weather enterprise in the world.

This is a *services ecosystem strategy*. NOAA amplifies its resources for providing weather services through the resources of companies such as The Weather Company, AccuWeather, Earth Networks, and my own company Global Weather Corporation. Indeed, these companies are only the tip of the iceberg, with many more behind them. If NOAA were to attempt providing the services of the ecosystem as a whole, its budget would need to be many times its current value. Some NOAA relationships within this ecosystem are contractual and formal, but most are informal, driven by NOAA itself or mediated through organizations such as the American Meteorological Society. It works. The 2012 National Research Council study *Weather Services for the Nation: Becoming Second to None* emphasized the importance of leveraging this ecosystem to serve the nation.

More recently, the Department of Commerce has formed a Commerce Data Advisory Council (CDAC) to advise the Secretary of Commerce on ways that improved access to all Commerce data can benefit the nation. One possibility is facilitating an ecosystem of organizations that access, organize, share, and add value to Commerce data, similar to the NOAA model. We know this makes sense, as illustrated through the tremendous value already provided by companies such as Zillow using Commerce data.

We need to extend this model of an ecosystem, used so successfully by NOAA on the downstream services side, to the upstream data side through a *data ecosystem strategy*. That exists only in rudimentary form today. Our goal should be to extend NOAA's existing data acquisition model, not undermine it. We need to move rapidly, but cautiously, to succeed.

What is in the data ecosystem? Data potentially available to NOAA through a data ecosystem may be divided into five classes. These are my informal categories, selected to illustrate the issues involved in this testimony. They should not be considered definitive, particular in their characterization of data quality.

- *Class I - NOAA-quality data.* This data is specified by NOAA, and generally acquired through systems built to NOAA requirements. It meets operational expectations for reliability, availability, and continuity. Examples include the GOES and JPSS satellite systems, the ASOS ground-based sensors, and NOAA ocean buoys. In addition, equivalent data may be obtained from international partners such as weather agencies in Europe and Japan.

- *Class II - Research-quality data.* This data is specified and acquired by a research organization such as NASA. It is often of a quality that satisfies NOAA needs for assimilation into NWP systems. It may not fully meet operational expectations of availability and continuity. Examples of highest-quality data include NASA research

satellites such as Aqua[7]. Other examples, sometimes of lesser yet still acceptable quality, include academic mesonets of ground-based weather stations.

- *Class III - Commercial-quality data.* This data is specified and acquired by a commercial organization. The data generally meets quality standards that satisfy the data's commercial purpose and are enforced by the acquiring organization. In some cases, such as with lightning data used in commercial weather forecasting, this purpose may be closely aligned with NOAA's mission. In other cases, such as vehicle temperature sensors, the purpose may be different and the quality standards may be lower. Some data, as from sensors on commercial aircraft, can be extremely high quality and reliable.

- *Class IV - Consumer-quality data.* This data is ancillary to consumer use of devices such as mobile phones. It generally has no quality standards and is not originally intended for weather application uses. However, there is an enormous and rapidly growing volume of such data. An example is pressure data from mobile phones.

- *Class V - Ad-hoc data.* This data is ancillary to a variety of business and consumer uses and is often poorly characterized. It may take a wide variety of forms. An example is Twitter data on storm impacts that can help guide rapid assessment of affected areas.

As used today by NOAA, this ecosystem is in its infancy. NOAA has traditionally focused its efforts on Class I data. Over the last decade, it has made increasing use of Class II data through access to NASA research satellites. The Joint Center for Satellite Data Assimilation (JCSDA), funded and operated jointly by NOAA and NASA, has played a key role in accomplishing this. It has been one of the success stories in expanding NOAA's data ecosystem. But there is still much research-quality data, such as from mesonets, which is not effectively used. Commercial data such as that from aircraft is not adequately employed. Existing NOAA systems, such as radar and surface observations stations, are aging. And Classes III-V data is used in only very limited ways.

Building a more robust NOAA data ecosystem is certainly not a simple endeavor. But, as with services, the benefits can be substantial. This is not an initiative that needs to be planned fully before implementation can begin. A robust data ecosystem can be built incrementally, through gradual changes to the present system. Key to success is setting long-term goals and strategies to start down the path of making this change. This was indeed the path taken with weather services during the 1990's and accelerated by the National Research Council report *Fair Weather: Effective Partnerships in Weather and Climate Services* in 2003. Many of the principles and

[7] Assimilation of NASA satellite data into NOAA forecast models has been a data ecosystem success story through a joint effort known as the Joint Center for Satellite Data Assimilation (JCSDA). Its efforts have ensured that NASA research data is sufficiently characterized to enhance forecast model performance prior to operational use.

guidelines established within this report for weather services may be applied to the development of a data ecosystem.

ADDRESSING CHALLENGES, LEVERAGING OPPORTUNITIES

Expanding this data ecosystem, as NOAA has done so well with services, makes sense. Yet there are always obstacles. NOAA's present observational system has faced a number of recent challenges. Most are well known and extensively documented[8]. They include:

- *Growing cost and procurement delays.* There is broad awareness of recent challenges with acquisition cost and schedule for NOAA's satellite systems. This has been a motivation for Congressional hearings seeking ways to improve the process. It is appropriate to question these acquisitions, and to seek improvements. Yet there is still enormous potential for addressing these issues from within traditional approaches to such data acquisition. Alternatives such as block buys, fixed price procurements, requirements simplification, and oversight streamlining present attractive options.

- *Aging technology.* As noted in the National Research Council *Weather Services for the Nation: Becoming Second to None* report, much of NOAA's present technology, such as radars and surface observation stations, was designed during the 1980's and built during the 1990's. Some have been upgraded, but the basic technology is now over two decades old. This limits its uses and potential improvements.

- *Limited flexibility.* The paradigm for NOAA's present observing systems is largely that of design-to-requirements. While this ensures that NOAA obtains the data it needs to fulfill its mission, it does limit flexibility and alternatives as well as access to new data sources that are unforeseen by NOAA. In some cases, this lack of flexibility translates into reduced robustness. We have seen this recently with the threat of a polar satellite gap and the challenging search for viable alternative data sources.

- *Restricted scope.* Among the biggest opportunities for new data capabilities is Classes III-V data. Partly due to its design-to-requirements paradigm, NOAA presently has no consistent means to access these advances. The growth is being driven by a variety of largely commercial trends, from use of big data to consumer adoption of mobile phones. Many of the uses of this data will be entirely new to NOAA, so substantial effort is

[8] The National Research Council completed two complementary reports in 2011 and 2012 regarding the National Weather Service. The first was a retrospective review titled *The National Weather Service Modernization and Associated Restructuring*, assessing lessons from that critical program. The second was a view to the future for the National Weather Service titled *Weather Services for the Nation: Becoming Second to None*.

required to leverage the data. One major constraint is that there is limited availability of Class III-V data for the atmosphere except at the Earth surface.

Evolving the existing NOAA data system would ideally resolve current challenges and create new opportunities. Establishing a truly comprehensive data ecosystem will require changing many of the traditional NOAA views of its data sources. This in no way means the new data necessarily replaces the old. Indeed, NOAA has many data needs that are unlikely to be met without data systems being built specially to their specifications. Yet the challenges of evolving today's NOAA data system into a more comprehensive data ecosystem should not be underestimated. A sample of the important issues includes:

- *Replacing government data sources with commercial.* Substituting commercial data for NOAA's Class I data is very challenging in practice. Class I data meets requirements developed by NOAA. Since those requirements are typically quite specialized, it will be rare for commercial data to exist that has not been specifically designed to meet NOAA's requirements. Without other markets for the data, NOAA effectively bears the whole cost of the data, whether provided as commercial data or as a system purchase built by commercial contractors. Yet a commercial capability, should one arise with a viable business model for at least some portion of Class I data, could bring value in terms of cost reduction. As noted below, NOAA would also need assurance of the existence of multiple sources. The replacement of Class I data through commercial sources is an area with large potential rewards, but also significant challenges.

- *Augmenting government data sources with commercial.* Expanding data sources to augment NOAA data, either to increase robustness or add new data types, is a wise strategy. This is particularly true for data sources that are already commercial products of Class III-V, available whether NOAA buys them or not. It may also be true for proposed Class I-II NOAA-centric projects, such as has been discussed for commercial sounding data, if demonstrated by rigorous cost/benefit analysis.

- *Assessing value of new or alternative data sources.* In most cases, it is not a simple matter to understand just how much new or alternate data sources can enhance NOAA's mission. Performing system-wide tradeoffs of data value are essential to any comprehensive data ecosystem. Traditionally, we trade off only one type of satellite data against another, or data only within one class rather than across classes to simplify the analysis. Such things as OSE/OSSE studies need to trade off a broad set of options, including satellite versus ground-based sources. NOAA should have available a flexible set of tradeoff tools, appropriate to the cost and risk of the new data being considered.

- *Technical capacity to use new data sources.* New data aggregation, analysis, assimilation, and statistics techniques will be needed to deal with new data sources. That is a broad

technical challenge for our academic community. For example, we know temperature observations from vehicles are of poor quality. With millions of them at any given instant, however, can we extract high quality data? This new way of working with data – instilling data quality after the observation is made, rather than designing it into the sensor – is among the research progress we will need.

- *Extending open data principles.* Any ecosystem strategy such as this leads naturally to a reassessment of the principle of free and open data, which if adhered to literally may preclude access to important data sets. In general, U.S. promotion of this principle, led by NOAA (and now more broadly by the Department of Commerce), is sound and should be applauded. It has been a foundational principle for the growth of all weather services within the U.S. Given the global nature of weather data, and the corresponding importance of data we use from other nations, every effort should be made to support this. But inevitably, there are some data sources that will not be made available to NOAA (and to the global weather community) under such open data conditions. Such data can contribute to NOAA's core goal of enhancing public welfare, including safety. By rigid adherence to the open data principle, such data – and the benefit to public safety that comes with it – may not be made available to NOAA or other international weather agencies. This presents a dilemma; in such cases, the open data principle may not serve the public good.

- *International agreements.* NOAA is committed to international policy agreements through the World Meteorological Organization (WMO). Their Resolution 40, in particular, states "members shall provide on a free and unrestricted basis data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations . . ." Details of this principle, including guidance as to what should fall within the domain of "free and open", are included in the resolution. The principle of free and open data remains sound, but WMO's implementation was developed in an era of vastly different needs from today. It is appropriate to refine the original resolution, and there is some indication that WMO is receptive to doing so. In particular, it needs to evolve from viewing commercial data as a risk to traditional weather service data to being a complement. Free and open data is not an end-goal of its own, but rather a means to best serve the public. When it begins precluding access to data that can help NOAA (and international partners) keep the public safe, it introduces issues of its own that need to be resolved.

- *Resources.* Finally, there is the inescapable resource challenge. Finding the resources to accomplish this may, in today's budgetary environment, be the biggest challenge. We know that NOAA's return on investment to the nation is enormous. Our economy suffers from a nearly $1 trillion economic inefficiency resulting from our sensitivity to weather

and climate[9]. Farmers experience this through drought, and energy suppliers through unseasonal weather. Reducing this inefficiency, through improved weather information, is a rare lever we have for driving economic growth. It is a worthy use of resources.

SEEKING INNOVATIVE PARTNERSHIPS

Our two trains will not hitch properly if we rely only on traditional public-private partnering mechanisms such as data buys. These mechanisms reflect the old information world from decades back, not the new. The new information world is characterized by business models, like freemium and shareware, that were unheard of when the data buy paradigm was first developed. The commercial information sector is innovating all sorts of new business models. It may be that none fit the need for NOAA's data acquisition, but the proliferation of new business models should itself be a lesson that new approaches can be found with focused effort.

Other U.S. government agencies have explored very innovative public-private partnerships. For example, the intelligence community has used direct investment in technology companies through the widely discussed In-Q-Tel non-profit venture capital firm to seed innovation. Key technologies that benefit us all, such as Google Maps, have emerged.

Could this be done within NOAA? The In-Q-Tel model may not be directly applicable, but it does illustrate the potential for new approaches. To illustrate the possibilities, consider a commercial satellite system that produces foundational data for NOAA along with additional data to be sold commercially. The additional data might allow post-processing of any NOAA forecast model using the foundational data to produce more accurate specialized results. This is not a perfect mechanism. But it does illustrate that new partnership ideas, with the potential to bridge the issue of open and proprietary data, are possible.

NOAA has a long and successful history of data buys. These include radar imagery for ice monitoring, ocean color data for identifying such things as algal blooms, lightning data, and more. NOAA claims that it has adequate procurement tools to accomplish data buys. Data buys will remain an important element of the data ecosystem, but innovative new mechanisms will be needed as well.

We may think of data buys as falling within one of two categories. In the first category are what we might call *project data buys*. They involve data specified by NOAA, systems designed specifically around NOAA's needs, and limited markets for the data outside NOAA – in essence, a data project. Benefits of this type of data buy, as compared to NOAA procuring the system

[9] Jeffrey K. Lazo, Megan Lawson, Peter H. Larsen, Donald M. Waldman, U.S. Economic Sensitivity to Weather Variability, *Bulletin of the American Meteorological Society*, June 2011.

itself, may exist but are limited. For example, if NOAA funding were not available, this data source would cease to exist. It is thus not an independently robust data source, and NOAA will likely pay the full cost of the data. The second category is *product data buys*. They involve data products for which there is a market separate from NOAA. The data source exists independent of NOAA, and can be considered independently robust if there are multiple suppliers (so failure of any one company does not jeopardize the source). As one of many buyers, NOAA would not be paying the full cost of the data. This distinction is critical for NOAA when considering options.

A successful NOAA ecosystem must, in the long run, be more than a list of data buys. An ecosystem is not necessarily a set of contractual relationships, but often simply working relationships and group interactions. This is what NOAA has learned so well from the services side. For example, the National Weather Service (NWS) has implemented a program called Weather Ready Nation that has developed thousands of informal partnerships already to amplify NWS efforts.

In many ways, NOAA already has a strong start on building an ecosystem. The Joint Center for Satellite Data Assimilation (JCSDA) is an excellent example of NOAA's willingness to expand the data ecosystem from operational to research satellites, as well as innovation in establishing new institutions and processes that make it possible. This paradigm should now be extended to the broader data community.

A PATH FORWARD

With expanding societal needs, NOAA will be required to grow capabilities at a rate that likely exceeds its resources for acquiring data. The best solution is to leverage data investments being made outside NOAA, in the commercial and academic communities. While NOAA will long need NOAA-specified data similar to today's GOES and JPSS systems, building an ecosystem of data suppliers – drawing from all five data classes and calling upon innovative new techniques – is a wise strategy to keep pace with the technological advances going on around NOAA.

I believe the concept of a NOAA data ecosystem, comparable in importance to NOAA's successful services ecosystem, is worthy of the substantial attention it would need for implementation. It will require guidance, support, and resources from Congress. It will motivate enhanced collaboration with NOAA's international partners to do similarly. And it will involve close collaboration with the community as a whole. To accomplish this, I would like to suggest the following:

1. NOAA, with support from Congress, should establish and build upon the concept of a *data ecosystem*, equivalent to what it has done successfully for services, to enhance its

operations. This will enable NOAA to better leverage the results of the information revolution going on throughout the commercial world.

2. NOAA should lead the international community in following this model. NOAA's efforts should be pursued within the context and goals of its international collaborations, including the WMO 40 data policies. NOAA should lead efforts to extend WMO 40 to recognize the context of new data sources. NOAA's ability to function within the context of global meteorology requires us to respect international definitions and guidance such as that for open data.

3. General legislative guidance on broadening the data ecosystem is valuable, but decisions on which particular data source options should be pursued are best left to NOAA.

4. NOAA, and Congress, should seek external guidance, such as through the National Research Council, regarding approaches and challenging issues (such as updates to open data principles) of this initiative.

5. As needed, a data ecosystem can be implemented in small steps toward the long-term goal of a vibrant data ecosystem. Near-term opportunities, such as the emergence of commercial options for satellite sounding data, should be used as examples to address and resolve issues, rather than deferred while NOAA establishes architectures or plans.

6. NOAA, and its data ecosystem organizations, should be informally guided in all efforts by the principle established during the Modernization of "no degradation of services", as well as the overarching goal of serving the public.

Weather legislation isn't considered within Congress often. In deliberating the evolution of data sources used by NOAA, I urge you to take a decade-scale view. The legislation you pass needs to stay relevant despite the enormous advances expected within information technology over that timescale. In this context, providing NOAA with the resources needed to develop a true data ecosystem will pay off to the nation many times over.

BIOGRAPHY

William B. Gail is co-founder and Chief Technology Officer of Global Weather Corporation, a provider of precision forecasts for weather-sensitive business sectors, and is the current Past-President of the American Meteorological Society. He was previously a Director in the Startup Business Group at Microsoft, Vice President of mapping products at Vexcel Corporation, and Director of Earth science programs at Ball Aerospace. Dr. Gail received his undergraduate degree in Physics and his PhD in Electrical Engineering from Stanford University, where his research focused on physics of the Earth's magnetosphere. During this period, he spent a year as cosmic ray field scientist at South Pole Station.

Dr. Gail is a Fellow of the American Meteorological Society and a lifetime Associate of the US National Academy of Science's research council. He is currently a member of their Board on Atmospheric Sciences and Climate, and has participated on many prior Academy committees, including the 2012 review of the National Weather Service and the 2007 Earth Sciences Decadal Survey. He is a member of the US Commerce Data Advisory Council and serves or has served on a variety of other editorial, corporate, and organizational boards. His book *Climate Conundrums: What the Climate Debate Reveals About Us* was published in 2014.

Chairman BRIDENSTINE. Thank you, Dr. Gail.
Dr. Bogdan, you're recognized for five minutes.

TESTIMONY OF DR. THOMAS BOGDAN, PRESIDENT, UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

Dr. BOGDAN. Mr. Chairman, Ranking Member Bonamici, and Members of the Subcommittee, and Mr. Perlmutter, thank you for the opportunity to testify today. My name is Thomas Bogdan and I serve as the President of the University Corporation for Atmospheric Research, or UCAR.

UCAR is a consortium of 105 member universities granting degrees in atmospheric and related earth sciences. UCAR's primary activity is managing the National Center for Atmospheric Research, or NCAR, and UCAR's Community Programs on behalf of the National Science Foundation.

NCAR is a federally funded research and development center with over 500 scientists and engineers conducting weather and atmospheric research, plus staff that manages supercomputers, research aircraft, and instruments to observe the atmosphere. Staff at NCAR and our member universities conduct research that leads to more accurate, timely, and useful weather forecasts, forecasts that our government, the private sector, and the public rely on.

As noted by the Chairman, data from multiple sources are essential if we are to maintain an up-to-date information system that will enable us to predict the weather and other environmental changes accurately. This is particularly important when we are dealing with costly weather events like tornadoes, hurricanes, floods, snowstorms, or extended periods of drought. The essential data come from a variety of sources, including the federal government, our universities, international partners, the transportation industries, and commercially owned and operated sources.

And today's sources for data and observations are really only the beginning. The technology in our vehicles and cell phones holds tremendous potential for crowdsourcing a wealth of local data. In my written testimony I give examples of how this is already in use.

With increasing amounts of open access to data, the power to process it, we have the capability to dramatically increase the accuracy of forecasts and expand the warning time for severe storms. NOAA and the private sector are investing in critical data acquisition. NOAA has begun dramatically increasing public access to these data, which will further expand scientific advancement and empower the ingenuity of the private sector to develop new economic opportunities.

The value of big data was demonstrated very clearly during Hurricane Sandy. Three days out, forecasters predicted to within 10 miles where landfall would occur. Twenty years ago, forecasters might not have been able to predict that unusual left hook that the storm took into the New Jersey coast. We know that thousands of lives were saved by the powerful combination of access to vast amounts of data, sophisticated software, and the computing power to run it, and a trained workforce to skillfully analyze it. And we know it's that same combination that will advance science and drive innovation going forward.

In closing, let me suggest three overarching principles for this Subcommittee to consider as it works through public policy for commercial weather data. First, atmospheric data must be of high quality, consistently generated, and remain in the public domain to meet the societal goals of resilience and the protection of lives and livelihood. The accelerated innovation and technical advances that the private sector can provide further serves this public interest.

Second, public access to data is essential for science to advance. Data openly available to the scientific community provide opportunities for widespread review and analysis that in turn drive innovative science and economic opportunities.

Third, we must ensure the benefits we receive through the reciprocal sharing of data and the insights with our international colleagues in Europe and elsewhere. This information is truly vital to the nation's public and private forecasters.

Over the last two decades, our collective ability to capture vital data and then process, interpret, and share it has transformed our understanding of the natural world and opened new economic horizons. To improve forecasts, protect the public, and advance the economy, we need to continue to make data available for public and private scientific research.

I appreciate very much the opportunity to participate in this hearing and would be glad to answer any questions. Thank you.

[The prepared statement of Dr. Bogdan follows:]

Dr. Thomas Bogdan
President
University Corporation for Atmospheric Research
before the
Subcommittee on the Environment
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, D.C.
May 20, 2015

Advancing Commercial Weather Data:
Collaborative Efforts to Improve Forecasting

Mr. Chairman, Ranking Member Bonamici, and Members of the Subcommittee, thank you for the opportunity to testify today. My name is Thomas Bogdan. I serve as the President of the University Corporation for Atmospheric Research – or UCAR.

UCAR is a nonprofit consortium of 105 member universities granting degrees in atmospheric and related earth sciences. UCAR's primary activity is to manage, on behalf of the National Science Foundation, the National Center for Atmospheric Research (NCAR) and UCAR's Community Programs.

NCAR is a Federally Funded Research and Development Center with over 500 scientists and engineers conducting weather and atmospheric research, and staff that manages supercomputers, research aircraft, and Earth observing systems. Our UCAR member universities and staff scientists conduct research for use by government and the private sector to further our understanding of atmospheric phenomena, and help to create more accurate weather forecasts across the nation.

As noted by the Chairman, robust data streams from multiple observing systems are essential if we are to maintain an up-to-date information system that will enable us to predict weather and other environmental changes accurately. This is particularly important for dealing with extreme weather events like tornadoes, hurricanes, floods, snow storms or extended drought conditions.

The essential data come from a variety of sources including the Federal Government, our universities, international observations, commercially owned and operated sources, from a variety of industries, and via aerial and ground based observing systems. And today's sources for data and observations are only the beginning.

Every car traveling our highways with their GPS system could be used to collect and transmit localized weather observations; ships and even pleasure craft can serve the same purpose to collect maritime weather and oceanographic data. The ever-present cell phone with the right sensor can become a barometer, a hygrometer that measures humidity, and

a thermometer. Under the right circumstances, data collected from many phones could create a network of millions of inter-connected weather stations.

Developments in instrumentation, monitoring, computational resources, and communication capabilities offer opportunities to supplement the vital data collection efforts of the Federal Government. The result will assist in the continued improvements in the accuracy of short and longer-range forecasts that we could have only dreamed about just 20 years ago.

While the opportunities and sources for data collection are expanding, we must continually invest in research to ensure that the data are robust, accurate, and meet the required standards for quality, continuity, and reliability. After all we are relying on data and observations to save lives and protect property.

Then there is "big data." NCAR and the UCAR universities have been gathering, modeling, analyzing, sharing, and yielding discoveries from big data for decades. When our Supercomputing Center opened two years ago, its 1.5-petaflop computing system was ranked among the 20 fastest in the world. With increasing amounts of open access data and the power to process it, we have the capability to dramatically increase the accuracy of forecasts and expand the warning time for severe storms. And that means we will save more lives, protect more livelihoods, and increase the economic resilience of where we live and where we work.

NOAA and the private sector are investing in data that will lead to improved forecasts and better protection of our lives and property, as well as a source of economic growth. NOAA produces an estimated 20 terabytes of data – that is twice the size of the entire printed collection of the Library of Congress every day. NOAA has embarked on a process to dramatically increase public access to these data and for this they should be applauded. There will be expanded opportunities for scientific advancement with NOAA's release of these data streams as well as economic opportunities pursued through the ingenuity of the private sector.

The value of big data was demonstrated with Hurricane Sandy. Three days out, forecasters predicted within 10 miles where landfall would occur. Twenty years ago, forecasters might not have been able to predict the unconventional left hook the storm took into the New Jersey coast. Thanks to the speed and power of our computational systems, the access to vast amounts of data from the many different observing systems, and our ability to turn all that information into actionable intelligence surely saved thousands of lives and provided the opportunity to minimize damage.

Critical to scientific innovation and advancement in atmospheric research is the availability of accurate and precise data; computational resources to process and model the information; and an educated and trained workforce who can interpret and utilize this information. Combined correctly this will drive science forward and will improve the accuracy of the daily, weekly, and seasonal forecasts.

In closing, I would like to suggest three overarching principles that the subcommittee consider as it works through public policy for commercial weather data.

First, essential atmospheric data must be high quality, consistently generated, and remain in the public domain to meet societal goals of resilience and the protection of lives and livelihoods. Furthermore, it is advantageous to provide the private sector with data and decision support systems. Accelerated innovation and technological advances that the private sector can provide further serves the public interest.

Second, public access to data is essential for science to advance. Data openly available to the scientific community provide opportunities for widespread review and analysis that drive innovative science and economic opportunities.

Third, we must embrace the benefits we receive by the reciprocal sharing of data and observations, and collaboration with our international colleagues. At the present time, we have access to vital data and observations made by colleagues in Europe and elsewhere. This information is vital for the modeling and forecasting by the public, universities and private companies.

Our ability to gather, process, and transfer observational and computational data is transforming our understanding of the natural world in ways that offer enormous benefits to society. Only within the last 20 years have we reached a point where we can do this kind of science on a global scale. Access to and use of this information has never been easier given the development of new technologies, new observing platforms, and advanced computational and communication technologies. We need to continue to make data available for public and private scientific research that will improve forecasts and better protect the public and our economy.

I appreciate very much the opportunity to participate in this hearing and would be glad to answer any questions.

Thank you.

BIOGRAPHY

William B. Gail is co-founder and Chief Technology Officer of Global Weather Corporation, a provider of precision forecasts for weather-sensitive business sectors, and is the current Past-President of the American Meteorological Society. He was previously a Director in the Startup Business Group at Microsoft, Vice President of mapping products at Vexcel Corporation, and Director of Earth science programs at Ball Aerospace. Dr. Gail received his undergraduate degree in Physics and his PhD in Electrical Engineering from Stanford University, where his research focused on physics of the Earth's magnetosphere. During this period, he spent a year as cosmic ray field scientist at South Pole Station.

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Chairman BRIDENSTINE. Thank you, Dr. Bogdan.

I'd like to thank all the witnesses for their testimonies.

Members are reminded that committee rules limit questioning to five minutes.

I'd like to now recognize myself for five minutes of questions.

I'd like to start with Dr. Pace. As I read your testimony, one thing stuck out to me and there was a sentence, a paragraph in here that says, "while at Commerce, we had debates over whether NOAA should explore the purchase of wind profile information and perhaps be an 'anchor tenant' for newly emerging firms. We did not pursue this course as NOAA's limited budget was already committed to existing programs with well-known requirements. Funds were not available for experiments, even ones"—this is the important point—"even ones that offered long-term cost savings."

So we had a testimony—Ms. Robinson mentioned it—we had a testimony a few months ago and my question was could we take a portion of what we are appropriating to NOAA and maybe fence it off for commercial data buys? And of course they were committed to existing programs of records. They were committed to, you know, not shifting any money to the commercial data buys. In your professional judgment, is there a time—you were dealing with this, it looks like, back in 1990 to 1993. The same issue back then is the same issue that we heard testimony on this committee regarding just a few months ago.

Is it your assessment that, number one, should we attempt to fence off some money for commercial data buys? And I guess number two on a larger scale, when we provide information for free to the world through WMO 40, is that a blanket kind of policy or should that be taken on a case-by-case basis? And I'll turn it over to you to answer those questions.

Dr. PACE. Thank you, Mr. Chairman.

Yes. I mean the—to be fair to NOAA, we were looking at a new entrepreneurial venture that did not have a long track record, had some very promising technical characteristics that we thought could be an experiment. NOAA, also rightly, saw its top priority as doing its existing mission and not necessarily in promoting the private sector industry. It saw its primary mission as, you know, doing the Nation's weather.

The argument really turned over what degree of risk the agency should take over what time horizon. From a near-term perspective, I think they were correct in saying, hey, we want every dollar to go toward our existing program of record. Our perspective, being in a bit of a different position, was that they needed to diversify their portfolio a bit and spend a small amount of money on longer-term or innovative experiments like this to give themselves options in the future. You know, there's an old saying that the urgent drives out the important. And their urgent issues there with weather satellite program I think really didn't give them, they thought, flexibility to do longer-term experiments.

Now, whether that particular experiment would have worked out or not I'm not really prepared to judge. But from a policy matter I thought they should have a more diverse portfolio even while the bulk of their efforts went into executing programs of record.

Chairman BRIDENSTINE. Knowing what you know now about kind of how this industry has now developed, going back to 1993, would you have suggested fencing off a portion of those funds for maybe commercial data buys?

Dr. PACE. I don't know that I would have taken money away from an existing program but I would try to have maybe worked with the White House and Congress to put together an experimental fund——

Chairman BRIDENSTINE. Got it.

Dr. PACE. —to say this is something that's not part of NOAA's primary mission because it's really part of commerce looking to promote innovation and that NOAA would be really the technical expert to define requirements and what the agency—and what would benefit the government, so being stewards of the public interest. But I would take it from a—maybe a larger perspective of promoting innovation more generally rather than just the NOAA mission.

Chairman BRIDENSTINE. And according to your testimony here, potential long-term cost savings.

Dr. PACE. Right. Well, an example of that is we had arguments over Landsat.

Chairman BRIDENSTINE. Sure.

Dr. PACE. And one of the issues in dealing with Landsat was incorporating new and advanced technologies. And part of our argument at the time was that we should have adopted some new technologies which are now showing up of course in small satellites to lower the cost of ownership of Landsat over the longer term. But again, a judgment was made that holding down near-term risk was more important than longer-term risks of cost growth. So again, that's an issue at NASA we also dealt with. It's a very, very common one.

Chairman BRIDENSTINE. Okay. I'm going to turn it over here in one second, but Dr. Bogdan, just real quick, you manage UCAR, which of course oversees and manages the COSMIC program, the partnership with Taiwan for GPS radio occultation. In order to do that mission, I would imagine NOAA had to produce standards and specifications for the data that is provided to feed the data assimilation systems in the numerical weather models.

My question for you is real simple. How difficult is it to make those specifications available to the public if they are providing it to you already?

Dr. BOGDAN. I don't see any difficulty from our perspective in making that information available.

Chairman BRIDENSTINE. Okay. Well, my five minutes is expired and I'll turn it over to the Ranking Member, Ms. Bonamici, for five minutes.

Ms. BONAMICI. Thank you very much, Mr. Chairman.

And I agree; this is a very impressive panel and I want to thank you, Mr. Chairman, and the staff on both sides of the aisle for working together to bring really the true experts. So thank you for being here.

Dr. Gail, welcome back to the committee. Thank you for all your assistance with the Weather Forecasting Innovation bill.

So, Dr. Gail and Dr. Bogdan, you both highlight in your testimonies the importance of maintaining free and open access to weather data and you talk about the benefits it provides to our economy and scientific advancement. And the current weather industry really stands as an example, I think, to the value of this policy.

So I'd like both of you to talk about how might a change, if there's more restrictive policy, how would that affect scientific and economic opportunities? What are the international implications if the United States is no longer able to freely share weather data without restriction? And what would be the effect on the industry? Because numerous commercial products and services have been developed as a result of NOAA data, how would this affect the industry if the weather data was not available freely and openly? So both of you could address that and then I have another question as well.

Dr. GAIL. Yes, thank you. I think the future is one of a mixed answer where we do want to maintain the goal of free and open data to the extent possible because that foundational data does really enable broad innovation throughout the private sector and throughout the industry as a whole, including the academic and government sectors. I believe it's different elsewhere in the world. I think we're a shining example because of that we have a very robust industry as a result.

This is not an all-or-nothing situation, and so one of the issues right now looking to the future is that we may lack data that we could otherwise use if we are completely constrained to a free and open policy. So we have to look—I believe the overarching goal is the public welfare here. So how do we best serve the public? And in the end it may be some aspect of a mixed policy.

Ms. BONAMICI. Thank you. Dr. Bogdan?

Dr. BOGDAN. When your data isn't out there and available, people can't look at it. One of the most amazing aspects of crowdsourcing today is with free and open data, anyone on the planet can look at that data and tell you how good it is, how bad it is, where it has blemishes, and what else it can be used for. And so I think we benefit so much from everyone being able to look at it.

On the second point, the atmospheric sciences community has a long history of sharing data because weather really respects no political boundaries. And so sharing data with our international partners openly and freely has been a cornerstone of how we have worked together across borders to protect the lives and livelihood. If we do not share our data openly, then there is always the option that our international friends and partners may choose not to share their data openly with us.

Ms. BONAMICI. Thank you. And I know we look forward to working with all of you to get that balance right. Sometimes the technology changes faster than the policy.

So weather is, as we discussed, a global phenomenon, and while interconnected, affects everyone differently. And I'm really excited about the potential that you, Dr. Gail, talked about to more personalized forecasts. My constituents in Oregon might be interested in knowing the wave heights from marine weather forecasts that

serve our commercial fishers and the good people in Oklahoma might be equally interested in soil moisture readings for their local farmers.

So I know the private sector has demonstrated an ability to react to these niche weather markets by taking NOAA data and adding value to it for the benefit of specific end-users. And during the consideration of H.R. 1561, I did offer an amendment to advance NOAA's partnerships in this space. I look forward to continuing to work on that.

Dr. Gail, how has NOAA contributed to sector-specific forecasts and how can they improve their support of private industries that provide these focused forecasts and products?

Dr. GAIL. Yeah, one of the interesting trends that we are facing is the sectorization of the forecast. So as I mentioned in my testimony, we're moving from a—sort of a one-size-fits-all forecast to a forecast for each particular sector and multiple forecasts within a particular sector. NOAA provides the foundational data for all of that. The private sector is really best at doing that customization, that sector-specific activity because it requires knowing each end-user's needs quite well rather than a broad set of users.

So it is in the end, I believe, a really tremendous partnership of foundational data, foundational services being provided by NOAA and then this sector-based customization that is provided by value-added providers, private sector and other organizations as well.

Ms. BONAMICI. Terrific, thank you. And I have another question, which I'll submit for the record because my time is expired. I yield back. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. And we might be able to do additional questions, maybe a second round as well.

Regarding this balance that I think we're all trying to strike here, I'd like to—Dr. Gail, you brought up I think an important point about the two trains. You have a government train and a commercial train and they're both going the same direction but maybe one's going faster than the other. If the government train required the commercial train to give all of its rides away for free, would the commercial train even exist? That's the question. And I think that's the balance that we have to strike. If we're trying to serve the global public good, we've got to have a market, and if we destroy that market before it even created, then that global public good would not exist.

I'd like to recognize my friend from Alabama, Mr. Palmer, for five minutes.

Mr. PALMER. Thank you, Mr. Chairman. And thank you to the witnesses.

Dr. Bogdan, in your testimony you say that atmospheric data must be high-quality, consistently generated, and remain in the public domain to meet societal goals of resilience and the protection of lives and livelihood. Let me ask you, what is currently being done to ensure that the data used to make reductions is high quality and how can we improve this area going forward?

Dr. BOGDAN. There's a considerable amount of validation and verification that takes place with data at various levels. That starts, for instance, with NOAA, the data to come in from their satellites. It also starts with data that comes in from private sources

as well. The careful screening of that data allows us to understand how it can be used and where it can be used. With crowdsourcing data, we have the ability to use many data points in a given area to understand the validity of certain data pieces that are there.

Mr. PALMER. What if the data that the private company collects is a higher quality—better than the government data? Is there any issue there?

Dr. BOGDAN. The academic world loves to work with data of all varieties and we like to work with high-quality data. And we really don't have a strong opinion as to where the data comes from. But the fact that our students, our post docs, our grad students can access those data and use them to understand more about the systems and in fact even help the individuals that have generated those data to understand their quality I think is a plus for everyone.

Mr. PALMER. Just—and a general observation from your experience, have you found commercial data to be equal in quality to the government data or in many cases superior to that data?

Dr. BOGDAN. I personally don't have experience of that.

Mr. PALMER. Do you have any knowledge——

Dr. BOGDAN. No, I don't.

Mr. PALMER. —that relates to that? All right.

You also said that public access to data is essential for science to advance data openly available to the scientific community provide opportunities for widespread review and analysis that drive innovative science and economic opportunities. Are there ways to provide access to atmospheric data while also fostering a commercial weather industry?

Dr. BOGDAN. I believe there is, absolutely.

Mr. PALMER. Do you—are there ways to ensure that it's widely disseminated while also ensuring that the commercial entities have an economic incentive to collect it?

Dr. BOGDAN. I think there are many ways to do that and that's why when this Subcommittee and others think about what the right policies are, it's important to have the public, the private, and the academic sectors at the table so that each side can bring forward their issues and their impacts. I think we can find many creative ways to create a business around the collection of data and also have that crowdsourced and used by universities as well.

Mr. PALMER. One last question for you, and that's in the context of that answer in collaborations with international partners. Could you elaborate just briefly on those partnerships?

Dr. BOGDAN. Through the World Meteorological Organization of which Laura Furgione is the permanent representative from the United States, there have been policies for many years about exchange of data between various met agencies. We rely on incredible data from EUMETSAT in Europe for our weather forecasting capabilities in the same way that they rely on our GOES data and our NPOESS data. So we have been exchanging these data all the way down to ground-based data as well that come in from various Mesonet networks.

Mr. PALMER. Ms. Robinson, the Hosted Payload Alliance has numerous contracts and it's involved in other federal agencies. How many contracts do your companies hold with NOAA?

Ms. ROBINSON. Zero.

Mr. PALMER. Zero. Is there a hesitation from NOAA on using the services of hosted payloads?

Ms. ROBINSON. In fact, they recently highlighted—NOAA highlighted hosted payloads as a key ingredient in their future space architecture program so we're quite encouraged to see that. And certainly as the Hosted Payload Alliance endeavor to furthering engage NOAA and help them to realize the benefits that commercially hosted government payloads can bring to the agency.

Mr. PALMER. So you see it as a possibility to leverage the commercial space sector's responsiveness and efficiencies while still ensuring that the government's weather sectors needs for mission reliability and operational utility are met?

Ms. ROBINSON. Yes indeed, and actually there are vehicles in place that NOAA has expressed interest in, including the U.S. Air Force, HoPS Hosted Payload Solutions contracting vehicle. So it is our sense from the Hosted Payload Alliance that they are indeed—NOAA is indeed pursuing ways to further leverage hosted payloads as a means of accessing space.

Mr. PALMER. My time is expired. Thanks, Mr. Chairman.

Chairman BRIDENSTINE. The gentleman yields back.

I'd like to recognize the gentleman from California, Mr. Takano, for five minutes.

Mr. TAKANO. Thank you, Mr. Chairman.

Dr. Gail, you mentioned, you know, the idea that if we are—that we might be limited in our opportunities if we are constrained to a free and open data policy. Can you elaborate on that a little more?

Dr. GAIL. Yeah. And again, the principle of free and open data is really a sound one, but increasingly, there are data sets that are associated with weather, maybe directly or indirectly such as pressure sensors on mobile phones, that may or may not be freely available to the government to use for weather prediction purposes. And without getting too specific about which ones are free and which ones are not free, at some level it would be a shame to not have access to all of that data to help improve our forecast capability. So I can certainly anticipate data sets that might not be free. So how do you make use of those subject to the general goal of free and open data whenever possible?

And so there are nuances here in this discussion that I think are going to be challenging to resolve; there's no question about it. But the goal is to have access to all of the data possible to improve weather forecasts.

Mr. TAKANO. But let's examine that—this line of thinking a little more. Let's just hypothetically talk about—I mean this is a—sort of a crowdsourced bit of information, right? We have data—pressure data that comes from millions of cell phones. How is that—is that a—in your mind a completely privately sourced information? Obviously, the millions of users are all part of the public but would that be possible without sort of the public airwaves or—I mean it's probably a privately owned spectrum but I mean do they—does the company—the cell phone company own that spectrum absolutely? Is it on lease from the government?

I mean I don't—I'm not an expert on this on this sort of law but I'm just saying that there's—there seems to be a lot of public assets involved in that and might not the public sort of claim, well, that sort of information really is in the commons? How can the cell phone company or communications company assert that they have sort of the right to some sort of profit off of it?

I mean they make money off of—there's a certain—they certainly make a lot of money off of the service they're providing but why couldn't we sort of say that this sort of crowdsourced information is in—for the benefit of the public and even globally, humanity, that we could set that global principle internationally that certain functions of millions of these cell phones, whether it's in Zimbabwe or Arkansas or wherever, that ought to be in the commons.

And I mean it shouldn't be that much of a—I mean how expensive would that be to, you know—I mean I could see them saying, well, this is more government regulation; you're asking us to provide pressure information for free. But another perspective is that, well, you're using the airwaves, I mean, there's only a limited amount of spectrum, you're in a sense leasing and renting this on a long-term basis, and this is for the public benefit. Do you have a response to that?

Dr. GAIL. And I'm certainly no expert on intellectual property in that particular arena.

Perhaps a better example—because I understand the point you're making. Perhaps a better example is the data that comes off of vehicles, off of commercial vehicles and consumer automobiles that comes out of some fairly sophisticated systems inside the vehicles often controlled by the manufacturer or by other parties related to that. And I think when you get into data like that, you're going to find that particular argument about being a public good maybe a little more difficult to make.

Mr. TAKANO. Okay. Well, I just—I wanted to kind of—I don't have a—this is a new area of inquiry for me and I—but I think we need to ask these questions. I mean I would have questions—that very specific example you're giving, you know, it involves public highways and certain—you know, there's a certain interplay of how public investment has made that information relevant but I can also see that there's been private investment in that software development and the particular devices. It's a very interesting, you know, area of inquiry for us to make the proper and fair public policy.

Mr. Chairman, I yield back.

Chairman BRIDENSTINE. I'd like to thank the gentleman from California.

I'd like to recognize that the—the Ranking Member of the Full Science Committee, Ms. Eddie Bernice Johnson, is here from Texas, and I'll recognize you in five minutes after our—we'll go to our side and then back to your side and you will be next in order.

I'd like to recognize the Vice Chairman of the Subcommittee on the Environment, Mr. Westerman from Arkansas.

Mr. WESTERMAN. Thank you, Mr. Chairman, and thank you, panel, for being here to discuss public safety, a very important topic.

Last week, a series of devastating tornadoes ripped through my Congressional District in southwest Arkansas. It resulted in the loss of two young parents' lives as they were shielding their 18-month-old daughter during the storm. I toured that disaster zone and was struck by just how dependent we are on these early warning systems. I know from talking to several of the residents there, there was one cell that passed over. Most people took cover and then the sirens went off again. And from looking at the devastation, you know, we were fortunate to not have more loss of life with the property damage.

But in your testimony you say that a fundamental element associated with our ability to reduce the impacts of these extreme weather events is the availability and use of reliable accurate weather. And you then say that in order for our nation to regain its preeminence in weather assessments and forecasting it is going to require well-defined and concerted efforts from the entire weather enterprise, in other words, public, private, and academic sectors, a topic we've all been talking about.

So my question to the entire panel is how can Congress better facilitate these efforts for these multiple agencies and enterprises to work cohesively together?

Dr. Pace, if you want to start on that one.

Dr. PACE. Thank you. It's a very important topic and I think one of the items that I brought up in a couple different settings is the foundational importance of the spectrum that both public and private systems depend on. I was struck recently by a briefing by the Aerospace Corporation, which was looking at the Emergency Managers Weather Information Network. There is—above that band are wireless communication standards for long-term evolution, LTE, that we all know and enjoy. It's a critical—but the Emergency Managers Weather Information Network is a critical NOAA broadcast that's relied upon by thousands of first responders nationwide for critical and severe weather warnings and it also triggers local tornado warnings, as you experienced. And one of the risks or concerns that I think folks in NOAA and the public safety side have is that very powerful LTE emissions next door pose a risk to the reliability and safety of the bands that NOAA uses.

There are other risks in the same general area. There are systems that use river and stream-gauge data to create flood warnings downstream that are—have a very critical public safety function. And so one of the things we try to bring up is that in the President's June 2010 Broadband Initiative Memo, he said specifically that any changes in spectrum need to take into account that we ensure no loss of critical existing planned federal, state, local, and tribal government capabilities.

And so as we're focusing on this commercial remote sensing issue, which I think is vitally important, foundationally we also need to look to make sure that the public safety spectrum that we rely on today is protected because if we don't, we will have disasters.

Mr. WESTERMAN. All right. Would anybody else like to briefly address that?

Ms. ROBINSON. I would if I could, sir.

In terms of the hosted payload community and what Congress might be able to do to help further facilitate leveraging commercial industry in order to get access to space more rapidly and more cost efficiently, I would suggest that H.R. 1561 is certainly a step in that right direction, specifically the endorsement of hosted payloads in the section that refers to specifically to placement of weather satellite instruments on co-hosted government or private payloads. It speaks to a broader initiative that would be of greater benefit across departments and agencies to make the use of commercially hosted government payloads a more regular means of accessing space and seeing this means of accessing space as part of the broader architecture and planning for it accordingly, budgeting for it accordingly as well rather than just a one-off mission, planning for it in advance, programming for it, and making it part of that future architecture.

Mr. WESTERMAN. Yes, sir.

Dr. BOGDAN. Just a quick comment, sir. The Office of the Federal Coordinator for Meteorology has been around for a number of years to try to coordinate activities in the federal sector. What we really need is a venue to bring together the public, private, and academic sectors who are very eager and willing to work together to leverage their unique capabilities to help us with extending lead times for forecasts.

Mr. WESTERMAN. Okay. I think I'm—yield back, Mr. Chair. I'll maybe have some questions later if possible.

Chairman BRIDENSTINE. You bet. The gentleman yields back.

The gentlewoman from Texas, Ms. Eddie Bernice Johnson, is recognized for five minutes.

Ms. JOHNSON. Thank you very much, Mr. Chairman.

I apologize for being late. I had a markup in another Committee. And I'd like unanimous consent just to put my remarks in the record.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF FULL COMMITTEE
RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you, Mr. Chairman. I'd like to extend a warm welcome and thank you to our witnesses for being here today to discuss the potential for increased use of commercial weather data by NOAA.

As many of you know, this Committee has long been invested in the successful development and maintenance of NOAA's observing capabilities. This data, especially, the satellite data, is critical to NOAA's mission to protect lives and property through accurate and timely weather forecasts and warnings.

While NOAA seems to have its satellite programs back on track, a history of mismanagement and cost overruns have caused many to question the future of the nation's observing capabilities and the possibility of increasing our reliance on the private sector to meet NOAA's space-based data needs.

This is an appropriate discussion to have and I am pleased that we will be examining that topic more closely today. That being said, I have a number of questions and concerns about how such an arrangement might work.

In particular, NOAA currently treats its data as a public good, sharing it freely with academia, the private sector, and our international partners. Any restrictions on the use and long-term availability of this critical data could have a number of unintended consequences such as stifling innovation not only in the development of our weather and climate models, but in the advancement of research and technology more broadly. This Committee has heard over and over again how data collected for one purpose has resulted in an unforeseen breakthrough in another area. Advancing

the use of commercial weather data cannot come at the expense of advancing research.

Additionally, I remain concerned about how the increased reliance on commercial entities may impact our international obligations and partnerships. Observing the Earth and its changes is a truly global enterprise and we all benefit from deep and long-lasting international engagement and data sharing. Anything with the potential to harm such arrangements must be dealt with from the beginning.

And finally, Mr. Chairman, I'd like to reiterate a comment expressed by my colleague, Ms. Bonamici, about the importance of hearing directly from NOAA regarding their plans to strengthen public-private partnerships in this area and the challenges associated with expanding those efforts. I hope will have the opportunity to hear from NOAA in at a future hearing.

Thank you and I yield back the balance of my time.

Ms. JOHNSON. I know that NOAA currently treats its data as a public good sharing it freely with academia, the private sector, and our international partners. Any restrictions on the use of the long-term availability of this critical data could be a number of unintended consequences such as stifling innovation not only in the development of our weather and climate models but in the advancement of research and technology more broadly.

The Committee has heard over and over again how data collected for one purpose has resulted in an unforeseen breakthrough in another area, so advancing the use of commercial weather data cannot come at the expense of advancing research.

With that, I'd like to ask, do we believe that the Department of Defense provides the best model for NOAA to follow or is there a more appropriate analogy for NOAA's data needs?

I guess I'll direct that to Dr. Gail and then whomever else.

Dr. GAIL. It's been many years since I've actually worked with the Department of Defense so I don't feel like I can really address that. They may; I just don't know.

Ms. JOHNSON. Anyone else? Yes.

Dr. PACE. Thank you. I think that's an excellent question because there's experience that the Defense Department has had with the National Geospatial Intelligence Agency. One of the things that happened when we created back when I was in Commerce with the Commercial Remote Sensing reforms is that DOD was a very big purchaser of privately produced data and there was both a private market for that data and there was a government market for that data. And NGA is a great purchaser of it.

It in no way replaces or gets rid of the need for government-owned defense systems. It is absolutely a supplement, a compliment, I think that in fact commercial data is easier for NGA to share with our friends and allies. So they're coming at it from the other direction.

In the case of NOAA, they share their government data widely and freely but they probably need to shift their portfolio a bit to allow for commercial data that is not treated the same as foundational science data. NGA has come at it from the other direction being a big purchaser and they've, I think, benefited from innovation by the private sector while still serving national security functions. So I think a conversation between NOAA and NGA might be helpful.

Ms. JOHNSON. Thank you very much.

In the 2001 National Academies' report titled "Resolving Conflicts Arising from the Privatization of Environmental Data," the

Academies recommended that avoiding market conditions that give anyone firm significant monopoly power is a critical consideration when transferring government data collection to the private sector. Can you please comment on the recommendations and ways to ensure competition and development of commercial satellite data?

Either one. Okay.

Dr. PACE. I think one of the things that probably NOAA and really any agency contemplated that needs to do is they're looking at making what in the private sector you call a make-or-buy decision. Is it better to make their own data with their own system or should they buy that data from others? And in doing so, they have to decide what risks they want to allocate between, you know, who the provider is and what they expect to happen if that provider fails to perform as expected and what fallback options exist.

Most critically, no one needs to gain and retain, I think, in-house expertise to ensure it can do due diligence and oversight of public funds when it goes out and purchases from the private sector. Again, when I was at NASA and we looked at doing commercial cargo and buying that, we were thinking about, yes, this may work, this may save money, we think this is a good idea, but we have fallback options. If that's delayed or doesn't work, what do we do next?

And so I think that part of the way you avoid getting captured into a monopoly situation is you always think about what's your fallback option, what rights do you have if the company falters while at the same time wanting to take advantage of the innovation and efficiencies that the private sector can bring.

Ms. JOHNSON. Thank you. Anyone else?

Dr. GAIL. Sure. I'll add to that because I think you've touched on a very important point here, which is the distinction between a commercial data market where that data exists independent of whether NOAA is a buyer or not or a relatively captive market, either a project to specifically specify the kind of data that is to be procured. And those two are very different scenarios that have to be addressed separately.

Ms. JOHNSON. Thank you very much. My time is expired.

Chairman BRIDENSTINE. The gentlewoman yields back.

The gentleman from California, Mr. Bera, is recognized for five minutes.

Mr. BERA. Thank you, Mr. Chairman. And thank you to the Ranking Member for this hearing.

Yeah, when I think about my region, which is northern California and the Sacramento region, available commercial weather data is incredibly important to us. Obviously, we're in the midst of a catastrophic drought right now, but, you know, when I talk to our climate scientists and so forth, with climate change many of them actually predict that we will have wetter winters but we'll have tropical rivers coming through that, you know, instead of getting the snowpack that we historically have had, precipitation will come down as rain. And as—you know, in our region we've got this dual risk of mitigating very real flood risks and we've had devastating floods in the region but then also the drought that were living through right now. And having that commercial data is incredibly important to us to managing how we capture that water, store that

water, and when we do releases or when we choose to hold onto additional water.

I am in general principle someone who believes with scientific data, the more open that data is, the better off you are. The more folks that can analyze that data, the better off you are. And also, I'm a firm believer in the public-private partnership, the fact that there are certain things that the federal government really has to do in terms of some of the advancements in some of the funding of research. But there are clearly things that, you know, the private sector, academia, and others can do as well in terms of the innovation.

So Dr. Brogan—or Bogdan, you touched on one area is, you know, what would an organization look like that's better navigated not just the federal side but then also the access to data and, you know, between the private sector, the public sector, and academia?

Dr. BOGDAN. I think you make a really important point about drought and the fact that our weather forecasts now need to begin looking out to seasonal, to interannual timescales. And this is an area in particular where I believe the private-public partnership belong with academia is going to yield tremendous advances. The ocean is the planet's memory on these timescales and so the atmospheric sciences community has really reached out and embraced the ocean community and we're working together to try to understand how we can take various sorts of data to give better, resilient forecasts so that city planners, water managers can understand what is likely to be coming down the line.

We need a place where I think groups can get together and know that the decisions they make will be important and will have impacts. And that clearly is where time is spent when outcomes can be guaranteed from those things. And here is a place again where I really see the importance of all sources of data, stream gauges, reservoir levels. The data we're going to need to solve the sort of problems that you're seeing in northern California will not be just the traditional sources.

Mr. BERA. And it is my hope that as you're collecting all that data from multiple sources, from individual cell phones, et cetera, that it is going into a big data set that again from my perspective you would hope that would be kind of an open source, that commercial entities might go in there, look at the data, evaluate that data, come out with predictions, et cetera, which I think it's perfectly fine then to sell that analytics to NOAA. But once NOAA purchases it, it is, you know, my sense that I would—as a federal entity, that you would hope that that data then is available to farmers and others, that if there is information that is coming out that is of public benefit and public good, you would want to make that available to the public.

I don't know, Dr. Gail, if you'd want to comment, or Dr. Pace.

Dr. GAIL. This is a great discussion. I do not see an inherent conflict between the principles of free and open data and commercial data sources. I think there are lots of individual issues that need to be worked out and challenges, but they're not inherently in conflict.

Mr. BERA. Right.

Dr. Pace, if you want to——

Dr. PACE. Yeah, I think it matters kind of where you are on a case-by-case basis of where you are in the value chain. I mean the raw data that may be of great interest to scientists who want the raw data to be able to trace it back and understand it, that's not necessarily what the customer wants. That's not necessarily what the person watching the evening news wants. They want information, not data.

And so part of the role can be to have open data widely available. Really the commercial is in the value-added, doing something more with it.

And in that regard I know sometimes—Mr. Chairman made a question that I didn't answer regarding the World Meteorological Organization. There's a thing called Resolution 40, which talks about free and open exchange of data. But in that it's very, very specific to certain kinds of data. There is no mention of crowdsourced data, you know, in WMO Resolution 40. There are certainly principles in there and there is certainly encouragement for sharing data, as you might imagine the meteorological and science community doing.

But as innovation has come along, I think we'll have to look at these international commitments, make sure we're meeting those international commitments absolutely because we want other countries to meet them. But at the same time to think about tailoring our own data policies to encourage that private innovation and get this kind of mixture that we want, and I think particularly in the value-added end is where the most promise lies.

Mr. BERA. Right. And I see my time is expired.

Chairman BRIDENSTINE. The gentleman yields back.

I'd like to now recognize the gentleman from Colorado, Mr. Perlmutter, for the next five minutes.

Mr. PERLMUTTER. Thanks, Mr. Chairman, and thank you for allowing me to participate in today's hearing. This is very interesting. I want to thank the panel for being here. I want to welcome my friends from Colorado for being here as well.

So stepping back for a second to us as policymakers up here, I mean I've got to look at what our foundational for me and the decisions that I make. So protecting lives, preserving property, I think advancing science especially on this committee, doing all of that, using tax revenues in the most efficient and focused way possible, and then listening to the testimony, your all testimony, there's really three pieces. It's capturing data, analyzing data, and disseminating data. So whether it's information, as you said, Dr. Pace, you know, to me, turning on the weather and trying to figure out is it going to be raining in Colorado, which it's been raining for 3 weeks straight and then we expect another 10 days, which is, you know, really unusual for us. But that's how I, you know, have to plan my day.

So what I want to see, and I'd open it up to the panel—and I'd start with you, Mr. Sternberg, since you haven't had much of an opportunity to answer things—I don't think there's anybody on the dais up here on our committee that really objects to a partnership among academia, the private sector, and the public sector to get to those three foundational things for us, protecting lives, preserving property, advancing science. How do you see this all playing out?

Mr. STERNBERG. Well, Congressman, thank you for recognizing me here.

It's an excellent question, and I think some of the topics that have already been discussed are highly relevant. The separation in my mind is exactly what you described, the generation of data and the generation of information, and who is responsible for those segments of the enterprise. So, for instance, in the context of what I'm familiar with with the lightning provision, my organization generates that data and sends that to the federal government for use.

Mr. PERLMUTTER. You capture it——

Mr. STERNBERG. We—

Mr. PERLMUTTER. —and then——

Mr. STERNBERG. Right.

Mr. PERLMUTTER. —analyze it and send it to the federal government?

Mr. STERNBERG. Absolutely. So we capitalize the assets that are the sensors and all of the equipment that is required, maintain that system, and evolve it over time to create a competitive data set. And it's competitive in the sense that it serves commercial markets, as well as the needs of the federal government. And so the distinction there is that I think the committee needs to understand that if there's—the section of delivering services to the community at large is what has built the weather enterprise. This $3 billion enterprise effectively has taken publicly available data and added value, as Dr. Pace had said, and providing that in the form of a myriad of services from deicing to cell phones for soccer fields and so on and so forth.

Mr. PERLMUTTER. Thank you. Ms. Robinson, so it seems to me just from your testimony you all are more in capturing data. Is that—am I mistaken?

Ms. ROBINSON. Well, I think in terms of hosted payloads, when you talk about those three foundational pillars, protecting lives, protecting property, and advancing technology, that third pillar really helps to accomplish the first two. So leveraging commercial satellites and that frequent access to space, as I've mentioned, we have on the order of 20 commercial satellite launches every year. So leveraging the space and capability on those commercial satellites to host an instrument, a weather instrument, other types of technologies that can promote that advancement, the technological advancement ultimately does save time, money, and lives.

Mr. PERLMUTTER. Okay. Thank you. So, Dr. Bogdan, I had a chance to meet with one of your colleagues, Mr. Rader. I think that's how—I said that right, didn't I? And as I understood the way he explained it, so we have NPOESS and JPSS and GOES satellites that accumulate a lot of data that then we make open to universities, to UCAR, and we're very happy to have NCAR in our State of Colorado. We're very proud of that laboratory. That big mass of data then is made available to the private sector and to academia, is it not?

Dr. BOGDAN. That is correct.

Mr. PERLMUTTER. And then private sector puts its secret sauce, its super algorithm—I don't know what it might be—to come up with these niche things. Is the question whether the federal gov-

ernment should have to pay to buy that back? Is that one of the questions we're grappling with?

Dr. BOGDAN. I think in some sense it is a question that we are grappling with here and the value-added component is something that I think we do look to the private sector to bring, the specific niche-type products and services.

Our academic community interestingly plays in all three of those areas you mentioned. They acquire data. Our universities are located within communities and they work within those communities to gather data. They analyze those data in Ph.D. theses and then they also disseminate it. There are many of my universities that actually sell products and services to local organizations. So they sit in all parts of that.

Trying to understand what is in the public good, and I think that has come up here many times, and separating it from what is in some sense a high-level, elite if you want niche-type product is something where we have to really look carefully on a case-by-case basis and decide what that is.

Mr. PERLMUTTER. Thank you, and I yield back, Mr. Chair.

Chairman BRIDENSTINE. The gentleman yields back.

And without objection, I would just like to follow up real quick with Mr. Sternberg.

You mentioned that you sell data to NOAA. Does your agreement with NOAA permit them to give that data away to anyone for free?

Mr. STERNBERG. So the arrangement is such that it protects the economic value of the data in certain commercial profit-generating sectors in the marketplace.

Chairman BRIDENSTINE. Will you hold that thought for one second? I want to come back to that but I've got one more person I need to recognize before.

Mr. STERNBERG. Certainly.

Chairman BRIDENSTINE. I'd like to recognize the gentleman from Illinois, Mr. Foster, for five minutes.

Mr. FOSTER. Thank you, Mr. Chairman.

Let's—one sort of big picture question I have is that there are a number of ways that we invest money. You know, you can invest in additional space-based or ground-based data collection facilities, supercomputing facilities, university and lab salaries. And all of—and so this overall optimization should be subject to a rough return-on-investment analysis to see if we are spending our money in the right place. You know, has that ever been done? What are the difficulties that come up when you attempt such an analysis? Anyone?

Dr. BOGDAN. It's something that we've wanted to do in our community for a long, long time. The difficulty and why we've not achieved it to date is the many ways in which weather, climate impact our economy, and they can show up all the way from routing of aircraft into impacts on trucking into property values. And so trying to really understand the economic impact on the one side, which is critical to the return-on-investment arguments I think have proved hard for us to do because of the many ways in which we connect. Understanding the impact of a tornadic outbreak of lives and livelihood, those are statistics that in some sense are

more easy to come by but they're not the whole story of how weather impacts our economy.

Janet Yellen about a year or so ago, head of the Federal Reserve, was talking about the sluggish economy we had in the winter quarter and coining a quote which I like very much that the weather was a "headwind on our economy" during that period. So it's something we would like to do and have been talking about trying to do as a community.

In terms of optimizing among the resources that are spent, the resources spent by the federal government and the private sector are both large and ways in which to optimize those require some capacity to get everyone at the table and start to think about it. The Federal Coordinator for Meteorology is again that agent within the federal government that looks across portfolios.

Mr. FOSTER. So have there ever been—you say there haven't really been efforts to do this?

Dr. BOGDAN. There have not. There have been incomplete efforts. Looking at certain parts of our economy, impacts, for instance, of hurricanes, extreme events, NOAA has put together a lot of wonderful data on what those costs are to the Nation. But there are more costs that are somewhat larger that are hard to get a hold of that really pervade day-to-day activities. Weather outbreaks that cause and traffic to snarl up, what are the costs in time, productivity, and so on. Those are large.

Mr. FOSTER. Yeah. Also when you talk about intensifying the sensor network around the country, first, you know, from a return-on-investment point of view, put those in established cities and where there are people there for obvious economic reasons, which gets into interesting political questions but—which I will not embellish here.

So is this something where, for example, a National Academies study or something like that would be appropriate or do you have the internal facilities to do this and simply haven't exercised them yet?

Dr. BOGDAN. No, I think we lack an organization with the authority and breadth to do that. The National Academies have had studies on many activities generally related to research activities and decadal surveys that come up, but we need to be looking both in the public, private, and academic sectors here, and that's something that I think is broader than our National Academies.

Mr. FOSTER. Okay. Yeah, well, if you have any specific suggestions on the way forward because that sounds like a very high-payoff activity to just optimally deploy. You know, it's not obvious to me whether we're spending more money on university salaries to develop better algorithms instead of faster computers, for example, would be the sort of trade-off you might encounter.

And let's see. I have 59 seconds here. Let's see. Do you encounter a lot of difficulties with classified equipment both in the United States and abroad where you know that there are these capabilities to, I don't know, for example, measure the heights of reservoirs, things like that, that—and then don't really have the ability to publicly make that data available? I mean is that a common problem that you have?

Dr. BOGDAN. Our organization does not do any classified work. I think it is clear that there is important classified information out there that can be helpful.

Mr. FOSTER. Okay. And have there been efforts to try to, you know, strip off some fraction of the classified equipment's output that would be useful or do you really have an absolute wall between those two?

Dr. BOGDAN. We maintain that wall.

Mr. FOSTER. Okay. And other countries as well?

Dr. BOGDAN. I do not know.

Mr. FOSTER. Okay. All right. Because that could be a very high-payoff activity for the world as a whole because, you know, often, because of cybersecurity problems, you know, a lot is known about other countries in our stuff already. We're not—these aren't really secret capabilities anymore and making them public could be worthwhile.

Anyway—but thanks so much. I yield back.

Chairman BRIDENSTINE. The gentleman yields back.

Without objection, we'll go into a second round of questions.

And kind of where I'd like to start is with you, Mr. Sternberg. You mentioned that in order to have an agreement with NOAA you actually have to protect the value of the data you're providing them, and that's embedded in your agreement. Can you share with us how that works?

Mr. STERNBERG. Yes. And maybe in reference to your very first question to this panel back in the same time frame where the discussion that Dr. Pace brought up regarding the wind profiles, 1992 the National Weather Service began adjusting data from the National Light and Detection Network, so at about the same time frame there was a recognition that private sector-generated data was important to the mission of NOAA.

And so the nature of the arrangement is such where, you know, I'm fascinated with the discussion about open and available data because I ask the question to whom? It's certainly the case that—when we distribute data to the federal government, NOAA and all the other agencies, is widely used within the confines of the federal government for academic research and through partnership arrangements that in that particular case with NOAA, that they've set up so they can engage and transmit that data for their mission. And so many ways it is serving a much broader, widely used purpose, which is in the spirit of these open data sets.

In addition to that, there are academic research arrangements that are facilitated through a number of channels within our company in particular to send the data to the academic institutions for research purposes. Where we draw the line is that obviously NOAA should not be in the position to transmit data to companies that are then utilizing the data for profit because then you sort of have a down-the-chain effect there. And so NOAA has been I would say very good at recognizing that they're not in that business.

And so, for instance, one example is in the private—in the public utility space. The requirements for public utilities when it comes to mitigating their transmission lines against lightning is a very unique and boutique market. And as you can imagine, the lightning information holds a specific commercial value for that par-

ticular area. And so for the general forecasting purposes, NOAA does an excellent job providing that lightning information for those applications and those forecasts. But when we're making decisions or the power utility business is making decisions on where to run their lines and how to ground those towers and how to mitigate those strikes against lightning, that's a very different conversation that I argue is in the hands of the private sector.

Chairman BRIDENSTINE. Dr. Pace, my understanding is that when it comes to ground-sensing instruments and even aviation-sensing instruments, the data that is provided to NOAA from those instruments is treated differently than data that is provide from satellites. Are you familiar with this and can you explain what the difference is?

Dr. PACE. Well, of course I have to demur and say that NOAA is really the more expert one to answer this. What I would say is that satellite data is often treated differently because of its space heritage than ground-based systems, and this is something we're running into on the commercial licensing and regulatory side, that as we impose more restrictions because it's from space than we would impose on the same sensor if it was on an aircraft or on the ground. So that's a regulatory distinction which is a problem.

With regard to the World Meteorological Organization, they do specify that certain kinds of data from aircraft or upper atmosphere sounding networks and so forth should be in the public domain but they're very specific about what those things are. So there is a general principle of sharing, but when it comes to actual obligations by the United States, it's much more narrow and specific.

And it allows for flexibility, as Mr. Sternberg has described, for creative meshing. For example, there was the commercial remote sensing of ocean temperature, ocean color, and it turns out that data is very scientifically interesting but it's commercial value is really in the first few days or a few weeks where it's of value to, say, a fishing fleet. So making data that's very near real-time as commercial only, then after it ages out a little bit, make that available to the broader scientific community, that's a compromise that I think worked fairly well. So, again, case-by-case analysis.

Chairman BRIDENSTINE. And last point, you mentioned remote sensing inside the Department of Defense. Can you share with us, once we went to commercial data buys within the Department of Defense and all of a sudden—what happened after that? Did we get more or less imagery? Were the revisit times more or less? Was the imagery more useful or less useful? Can you share your opinion on that?

Dr. PACE. Well, the actual details are probably not shareable in a public domain, but what I would say is that there was great interest and enthusiasm and support for buying commercial remote sensing imagery. And of course it waxes and wanes depending on what defense obligations are. So, for example, in the aftermath of the wind-down of combat operations in CENTCOM, there's been relatively less that's been purchased.

But one of the primary benefits that people had from it was one, you offloaded other more higher priority national systems that could go focus on things that only they could do; and two, you had

data that because it was derived from a commercially licensed system could be more easily shared with our coalition partners. So it actually facilitated cooperation and data sharing in ways that government systems had a hard time doing. So it's kind of the opposite problem of NOAA.

Chairman BRIDENSTINE. So if a government agency were to be interested in purchasing commercial data, it would free that agency to focus on things really that the government is better at doing and allow the commercial industry to focus on things that commercial industry can do?

Dr. PACE. Right. And that is part of what I mentioned about sort of a make-or-buy decision. Now, one of the considerations in that is if the government does something that maybe discourages data sharing, you know, you could be less well off so it needs to be—have a very careful analysis. And as my colleagues here have said, this is where a discussion of—not only between NOAA and the State Department and NASA are important, there ought to be industry input to the Department of Commerce so they can make a more informed judgment about how to craft a data policy going forward. And so I think the more we think about that, the better off we'll be.

Chairman BRIDENSTINE. I am past my time.

I'd like to recognize the gentleman from California, Mr. Takano, for five minutes.

Mr. TAKANO. Thank you, Mr. Chairman.

Dr. Pace, did I hear you correctly, you—there was—I wasn't attending fully earlier in the hearing about a discussion on public safety spectrum and the need to preserve it. That caught my attention and if you could sort of revisit that a little more and explain to me your concern about preserving public safety spectrum and why it's so important.

Dr. PACE. Sure. Well, the primary thing is there is, as is well known, a—quite a demand for more mobile broadband spectrum. You know, we all use it, we all have—carry phones and so forth on it.

Mr. TAKANO. Enormous commercial, economic pressure.

Dr. PACE. Absolutely, enormous commercial, economic pressure and for understandable reasons. And some of the areas of the spectrum where that pressure is most acute are in areas where we have GPS operating, where we have meteorological aids operating, where we have remote-sensing systems operating. And so space signals are very, very weak, and so if you have any sort of interference, it's fairly easy to do. If you have a very, very powerful next-door neighbor like a high-powered communication system, that can affect you.

And so among the systems, there is a recent auction of spectrum—and apologies for this—1695 to 1710 megahertz—sorry, I wasn't going to do that. But in that auction some fairly powerful communication systems are being allowed to go there, so as we move forward, adjacent systems operating such as the Emergency Managers Weather Information Network are at some risk. There's some Aerospace Corporation study that's public that I can make available if you would like. And the EMWIN is a NOAA system which provides support to first responders for critical and severe

weather warnings, and some of the systems even trigger automatic local tornado sirens directly from the satellite broadcast without human intervention. Okay. That's very timely. But if there is interference to that or if the reliability level drops, then those warnings aren't going to be as effective. So I'm not saying this is an immediate crisis but this is something that I think, you know, NOAA and as public safety people we need to pay attention to.

Other systems in the nearby band deal with radio transmissions for stream gauges that do flood warnings, so there's a lot of infrastructure that uses public spectrum for safety purposes, and that as we're looking at this intense commercial pressure, we have a public-private sector set of interests that we have to balance and make sure we get right.

Mr. TAKANO. Are you aware of shortwave spectrum? I was having a conversation with someone about shortwave, that there's new technology to utilize shortwave radio spectrum that was previously not so useful.

Dr. PACE. At—

Mr. TAKANO. Are you familiar with this topic at all?

Dr. PACE. No. I can speculate but I don't have direct knowledge.

Mr. TAKANO. Okay. So you're talking about a need to guard what spectrum we have. I'm not familiar completely what the spectrum was so that once that spectrum is sold off and auctioned off to private users, it pretty much is gone, is that right?

Dr. PACE. No, not necessarily. Some of the spectrum is shared. There are conditions that are placed on the spectrum. So NOAA, for example, has spectrum managers who watch these issues. They report up through their chain of command at NOAA. NOAA is in part of the Department of Commerce. Within the Department of Commerce is the National Telecom and Information Agency, which really represent all federal agencies and then speaks to the FCC. The FCC is an independent commission, doesn't report to the President, and so there is a dialogue that occurs between FCC and NTIA. And NTIA's job is to represent the interests of the federal agencies to craft, you know, technically balanced solutions that protect those range of interests. So it's a bit of a complex process but, you know, NOAA is represented in there. But again, sometimes some of these smaller details can get overlooked.

Mr. TAKANO. Real quickly, anybody can jump in, where is any particular—where we're at risk in the current context of significant monopoly power sort of interceding into the issues that we're discussing today? In other words we want to avoid market conditions that give any firm significant monopoly power. Where might that monopoly power arise and where should this committee be especially worried? If there's anybody that has any thoughts on that. Go ahead, Dr. Pace.

Dr. PACE. My apologies. People can interrupt me.

I think the chances of monopoly power, absent a government mandate or regulation creating monopoly power, are really quite small.

Mr. TAKANO. Okay.

Dr. PACE. And the reason for that is because space is increasingly globalized, and if somebody attempted in the United States to create a monopoly power, I can assure you there'd be people

overseas who would seek to challenge that and offer something else.

So I think the real trick here is to making sure that we regulate in a way that promotes our firms, that we protect foundational spectrum underneath which we all depend, that we use government power to be a good customer and good purchaser in the public interest, and that we promote open data sharing of foundational scientific data to really make sure that the U.S. interests are advanced. So I don't think the chance of monopoly power in this area is that great because I think that really the world is much bigger than just the U.S. domestic market.

Mr. TAKANO. Great. Mr. Chairman, thank you.

Chairman BRIDENSTINE. Thank you. And I would like to maybe second that notion that the monopoly power that's of concern to me is the current government monopoly of space-based weather data. The goal here is to create a competitive market that's not a government monopoly.

I'd like to recognize the Vice Chairman of the committee, Mr. Westerman from Arkansas.

Mr. WESTERMAN. Thank you, Mr. Chairman.

And Mr. Sternberg, in your opinion, is collaborating with NOAA an easy process?

Mr. STERNBERG. I would say yes, it is. And specifically, through what is now the Weather-Ready Nation Ambassador Program, I think that's been an excellent program that NOAA has recognized that they can't do it all themselves, and through this ambassador program, it provides the private sector an opportunity, as well as the community at large and the entire enterprise somewhat of a seat at the table to openly discuss the issues that we're talking about today. So I would compliment them in that particular initiative to do that.

I would also compliment them in the manner in our experience from the cooperative research and development programs that they've facilitated, and this is an opportunity for the private sector to truly partner as opposed to a contractual arrangement with the scientists within NOAA and other private sectors in academia to really develop on a long-term basis certain search programs.

Mr. WESTERMAN. So have they ever changed the terms of your contract in regards to the openness of data?

Mr. STERNBERG. So, you know, typically these contracts are multiple years in scope that are then appropriated from year to year. So there's a natural discussion throughout what has now been about 20 years, if you will, contractual arrangements with NOAA and other federal agencies. So the topic comes up obviously in the normal contract cycle, as does the performance enhancements and the evolution of any observation network.

Mr. WESTERMAN. And shifting gears a little bit, can you characterize how a commercial model for lighting data has impacted the price, quality, and rate of innovation in the data that Vaisala uses or provides?

Mr. STERNBERG. Yes. So, you know, part of the—part of my written statement talks a little bit about how when there's a viable commercial market for a data set, not only does the organization that's feeding that data set allow to take those profits and reinvest

those into advancements within the network to create higher-level data or higher levels of performance. Over the history of the NLDN, over 30 years, there's just been some outstanding reinvestments that have gone into the network. There's both the commercial organizations that are bringing that data in, as well as the federal government get that uplift. And that is truly a win-win situation.

The best example has been that NOAA back a number of years ago was interested in lightning data outside of the coast, off of the landmass specifically to look at the Atlantic hurricane basin. And so the technology was not there at the time to really do that and through reinvestments over time and collaborations between the academic and public sector, we were able to advance that science to what is now a global visualization of lightning over the oceanic and the landmass regions. So that's a perfect example of how that commercial sector stability and profits can be reinvested in a partnership arrangement with the public sector to really satisfy the needs of both parties.

Mr. WESTERMAN. Okay. And, Dr. Bogdan, it's my understanding that other agencies around the world in the Europe and the U.K. do not operate under the same system of fully open data and in fact are hybrids of public and private companies. How do they make this issue of open data work?

Dr. BOGDAN. There are different groups that actually charge around the world for weather products that they put out. The European Centre for Medium-Range Weather Forecasts, for instance, does not make their model outputs available. That must be purchased. They also—organizations will purchase different amounts of data.

What tends to separate the data that is shared from the data that is not tends to be its global nature. Everyone needs global data to understand where they live in the larger weather patterns that are going on. You might consider very localized data that could be dealing with soil moisture in several counties in Arkansas, for instance. The importance of that data to a European weather model is nowhere near as important as global GPS radio occultation might be to it. So often the decision to keep certain data private versus public has to do with the locality and whether it scales globally or not.

Mr. WESTERMAN. And I thought soil moisture in Arkansas was important to everyone, but with that, I'll yield back, Mr. Chairman.

Chairman BRIDENSTINE. The gentleman yields back.

The Ranking Member from Oregon, Ms. Bonamici, is recognized for five minutes.

Ms. BONAMICI. Thank you very much, Mr. Chairman. I apologize. I have a—had another hearing going on at the same time, so I really appreciate the second round of questions. And thank you to our great panel for sticking with us, and again, thank you for the opportunity.

So for years we've been using this current system where NOAA maintains and operates a suite of observing satellites and purchases a supplemental ad hoc data to enhance their forecasting products. But as NOAA continues to expand its procurement of commercial data and expands its public-private partnerships, we

may run the risk of ceding critical observational capabilities to the private sector.

So I want to ask each of you, are there essential observational capabilities that should always be operated by the government or conversely, do you envision a system where the United States does not maintain satellites and exclusively purchases from private companies? What do you think, each of you?

Dr. BOGDAN. Let me start. I think that again we have to look at these things on a case-by-case basis, so it's hard, unfortunately, to draw on generalizations. But if there is one, I think it is that when we have global data sets, data sets that span the entire planet, then all of us live underneath those data sets and one can understand that there's generally a strong argument for that to be in the public good to be out there.

Ms. BONAMICI. Thank you. Anybody else?

Dr. Pace?

Dr. PACE. And generally I agree with that perspective on global data sets. However, I would point out that there are certain foundational data sets that are already talked about, you know, in the WMO that serve the models. And so new innovations that come along I think we should be able to think anew about what to do with them.

So again, I'm a fan of GPS radio occultation data. It uses receiver systems that NASA helped develop, which I'm sort of proud of. But whether or not GPS occultation data can be a privately provided innovation, whether it's a data product from it that is what's commercial, whether it may be makes its way into the foundational data the WMO, you know, covers as a mandate, I think that's something that ought to be debated and it's probably an interagency discussion to include state, NOAA, NASA and have some industry input, as well as the members of this committee.

So I think we want to make sure we don't mess up our foundational systems, the programs of record in GOES and POES, but then as we have an opportunity to add new innovations, we should think about what's the best way going forward to making sure that's really, really robust, and is there really a commercial market for this—

Ms. BONAMICI. Right.

Dr. PACE. —or is this still really fundamentally the government is really the only major customer?

Ms. BONAMICI. I appreciate your expertise.

Mr. Sternberg.

Mr. STERNBERG. Yeah, I just also wanted to comment that certainly as it's relevant to a satellite observing system, it's equally as relevant to surface observations and aerial observations, and so the same discussion that we're having in this context should also be extended to surface and aerial observations.

Ms. BONAMICI. I appreciate that.

Dr. Gail or Ms. Robinson? Dr. Gail?

Ms. ROBINSON. Thank you.

I think as we've seen in a myriad of departments and agencies and their means of accessing space-based capabilities, there are certain capabilities that should continue to be provided by those departments and agencies, but where the government can rely on the

commercial industry, we should. I've heard Chairman Bridenstine on a number of occasions quote the government ought not be doing what commercial industry can be doing for them, and I think that's absolutely the case.

And when it comes to commercially provided hosted payload capabilities, it does offer a degree of resiliency, as well as frequency to orbit with the robust launch pipeline. And when you look at the cost of some of these large time-intensive government satellite systems and then the benefits that can be provided by commercial hosts, it's pretty staggering to see how quickly you can get on orbit at a fraction of the price with a level of reliability that—

Ms. BONAMICI. Thank you.

Ms. ROBINSON. —is known to be acceptable.

Ms. BONAMICI. Dr. Gail?

Dr. GAIL. So I think you've asked a question for which there probably is no answer, could the future be entirely commercial? And it's possible. So now really is the time to be building those principles to understand what should guide us in that evolution, which should be retained within the government, and what can be commercial. And I don't think we know what those principles are completely yet.

Ms. BONAMICI. Thank you. And real quickly, following up on the gentleman from Arkansas's question about international collaboration and differences, Dr. Bogdan, are you familiar with the COSMIC–2 program funded by Taiwan? It's expected to provide very useful ground-based radio occultation data at costs that are dramatically below the conventional NOAA satellite program. Do you—what role is UCAR playing in this program and what role do you see the private sector playing in this area going forward?

Dr. BOGDAN. UCAR has hosted the COSMIC Program Office and we work closely with Taiwan and our U.S. partners, NOAA, the Department of Defense, and NASA, and also the National Science Foundation on that. We process the data initially and then move it out quickly to the National Weather Service.

It's been estimated that with the new COSMIC–2 program there'll be about 13,000 occultations per day over the planet. Studies have shown that we can actually profit from up to 130,000 occultations a day. And so we see that there is a lot of room for other providers of GPS radio occultation data before the models that benefit from them are saturated with those data.

Ms. BONAMICI. Thank you so much. My time is expired. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. I'd like to thank the Ranking Member for her questions. She yields back.

I appreciate the reference from Ms. Robinson. I do believe that the government ought not do what the commercial sector can to the extent that we have a robust, competitive market that drives down costs and increases innovation. I don't think we need to replace a government monopoly with a commercial monopoly, but thank you for that reference. I think you captured it well.

I'd like to recognize the gentleman from Colorado, Mr. Perlmutter, for five minutes.

Mr. PERLMUTTER. Thank you, Mr. Chairman. So my question is—and I'll start with you, Dr. Bogdan, and then to you, Dr. Gail, since

I want to talk to the guys from Colorado. See, that's why they put male this committee, because I just talk about Colorado all the time.

So big data, all right, and Mr. Sternberg talked about he captures this data, analyzes it, sells some of it—or sells it to the—to us, the United States. There may be some strings attached in his contract. So a lot of what we're talking about—I'm a lawyer—sounds very contractual to me and, you know, how do you cut the deal between the two? What strings are attached? What aren't attached? You know, who is it—you know, do we do it commercially or not?

But now there's all this data and we have—you have the ability at NCAR, we have the ability among the laboratories to analyze a lot of this data. A lot of it we don't really—you know, we look at a lot of it. There may be something five years from now that helps us pinpoint something. I mean this is evolving every day.

Is—who is capturing this—who is archiving this data and who has access to the library? Or is that something we've been thinking about?

Let's start with you, Dr. Bogdan.

Dr. BOGDAN. It is something we've been thinking about for a long, long time because we are literally drowning in data. And it's important to note that data does not necessarily equal information. It does not necessarily equal understanding. Some data are very redundant. We capture those data I think each in our own separate ways. We curate a lot of data at the National Center for Atmospheric Research but so does NOAA at its data centers, the National Climate Data Center in Asheville, our National Geophysical Data Center in the Skaggs Building on Broadway and Boulder. NASA has increasingly asked its PIs to take the critical data from their mission and curate it.

I think the future will be those data will be living in the cloud along with virtually everything else we do and that they will have their own proprietors and owners and people that keep up with it. But there is a hidden cost to maintaining data and we're going to have to think in the long-term about those costs and who bears those costs for those data. So it's a very pressing question and one that I think we're all struggling with but understand the importance of getting the right answer.

Mr. PERLMUTTER. Dr. Gail?

Dr. GAIL. Yeah, this is a question that's present in a lot of people's minds these days, and there are two separate initiatives right now, separate but related initiatives, one within NOAA to bring their data out more readily into the public domain working in partnership with a number of large private sector companies, and a separate initiative at the Department of Commerce level with a committee that's been formed to look at how to get Department of Commerce data and all of its value out more easily into the public. And so those are things that are being worked on right now because of recognition of exactly what you said.

Mr. PERLMUTTER. Okay. Mr. Sternberg, in your—with your company and its relationship with NOAA—and I may have not heard this correctly—is there some limitation in terms of NOAA's use or

its ability to disseminate the data that it gets from you under your contracts?

Mr. STERNBERG. Specifically in the context of the lightning data, the last thing that we want to do is throttle innovation with our data. And so the arrangements are typically written such that there is an opportunity for any—for federal agencies, NOAA in particular, to share that information within their partnerships or their programs as they see fit towards their mission. And so——

Mr. PERLMUTTER. But would there be a limitation though to make it free and open to, you know, somebody down the block who's not a federal—you know, isn't in a federal agency?

Mr. PERLMUTTER. Yes, and there is a limitation and they're entirely to protect certain commercial markets for that product.

Okay. So—but again, this is a contract that you've reached with NOAA——

Mr. STERNBERG. That's correct.

Mr. PERLMUTTER. —so you're able to set the parameters. They can say yes, no, or maybe if they want to enter into a contract with you or not?

Mr. STERNBERG. Yes. I would call it more of a balance because, you know, if the—back in 1992 there wasn't a lot of this happening and so this has evolved over time, and yes, in a contractual RFP-type of context but moreover in terms of a balance of the recognition that a private sector organization can equally lead the development and the investments going into a network that creates this data set. So I just want to stress that that is a balance. It is correct but it is——

Mr. PERLMUTTER. No, and I'm not——

Mr. STERNBERG. —but it's also a——

Mr. PERLMUTTER. —complaining about it.

Mr. STERNBERG. Yeah.

Mr. PERLMUTTER. I'm just saying it's—you know, I'm just a lawyer and I—that just sounds like a contract for me and you've got certain provisions that are important to you and your company and your ability to sell, you know, within the private sector as well. You have other customers.

Mr. STERNBERG. Correct.

Mr. PERLMUTTER. And you want to protect those customers. NOAA doesn't have to do a deal with you.

Mr. STERNBERG. That's right.

Mr. PERLMUTTER. And they say, no, we're not going to go along with that or yes—yeah, we'll live with that.

Mr. STERNBERG. Um-hum.

Mr. PERLMUTTER. So I just appreciate that. Thank you for your testimony.

Mr. STERNBERG. One other point though I just wanted to say is that it is possible to procure the exclusive data rights for free distribution however the government would see fit, so that is an opportunity that any Federal agency would have. Of course, that is again a contractual and a financial negotiation at that point.

Mr. PERLMUTTER. Okay.

Mr. STERNBERG. So it's not eliminated by the contract; that is open to any agency depending on what their goals and objectives would be with that data set.

Mr. PERLMUTTER. Okay. Thank you. I yield back.

Chairman BRIDENSTINE. I thank the gentleman from Colorado for your attendance today. One point I'd like to make before we close here is, Dr. Bogdan, you said 13,000 radio occultations per day is what we currently get with COSMIC–2?

Dr. BOGDAN. That's what we will be getting——

Chairman BRIDENSTINE. We will get.

Dr. BOGDAN. —with COSMIC–2.

Chairman BRIDENSTINE. Okay. And you're saying we can get up to 130,000 occultations per day before we hit diminishing marginal returns?

Dr. BOGDAN. That is what the studies show.

Chairman BRIDENSTINE. That's pretty amazing. And I think what's important here, earlier you were talking about the difference between global data sets and regional data sets and that being differentiated between what's given away for free and what there's a market for. When you get up to 130,000 occultations per day, the fidelity gets down to the point where global data sets actually are very impactful at a local, regional level. And so this is a balance that we're going to have to figure out how to address so that we can create the market to get those 130,000 data sets, 130,000 radio occultations per day.

I have one last thing. As I mentioned in my opening statement, last night the House passed H.R. 1561, the Weather Research and Forecasting Innovation Act of 2015. I want to make sure before we close that everybody understands that this would not be possible without the Ranking Member, Ms. Bonamici from Oregon, for her hard work to make this a very bipartisan effort, and that's critically important.

Our committee received enormous support for our weather legislation, including companies from the evolving private weather sector. I'd ask unanimous consent to enter into the record letters of support for our bill and for this hearing in fact from Geo Optics, Planet IQ, Spire Global, Tempus Global Data, Panasonic Avionics Corporation. And without objection, so ordered.

[The information appears in Appendix II]

Ms. BONAMICI. I have no objection, Mr. Chairman.

Chairman BRIDENSTINE. Roger that.

I thank the witnesses for their valuable testimony today. It was a highly enlightening panel. I thank the Members for their questions.

The record will remain open for two weeks and additional comments and written questions from Members will be permitted for the next two weeks. This hearing is adjourned. Thank you for attending.

[Whereupon, at 12:05 p.m., the Subcommittee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Scott Pace

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
Subcommittee on Environment

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts

Questions for the record, Dr. Scott Pace,

Director of the Space Policy Institute, George Washington University

Questions submitted by Rep. Jim Bridenstine (R-OK)

1) Please elaborate on NOAA's public-private partnerships with surface-based, aviation and space-based data providers, in the context of proprietary data, and the current licensing construct that exists for them?

I am not familiar with NOAA's existing public-private partnerships in the context of handling proprietary data. What I can say is that there is no fundamental prohibition in international law, national policy, or legislation that would prohibit the acquisition or licensing of proprietary data and software to meeting NOAA mission needs.

There is certainly an agency preference for data that can be shared openly with the world meteorological community. Open data policies can and are desirable for scientific purposes and for promoting greater international cooperation, however, such policies are a means to an end, and are not ends in itself. NOAA may choose to buy global distribution rights to proprietary data but if it does so, the cost is likely to be high as the selling firm will not be able to profit from selling to other customers. NOAA would have to balance the costs and potential loss of innovation resulting from this approach with the affordability of acquiring a government system to produce the same results.

2) Please elaborate on your role with regards to NOAA'S Science Advisory Board. Have you noticed a lack of willingness to work with private sector companies to incorporate data for weather forecasting?

I am a member of the NOAA Commercial Remote Sensing Advisory Board whose charter encompasses NOAA's commercial remote sensing licensing responsibilities. The responsibilities resulted from Title II of the Land Remote Sensing Policy Act of 1992. As covered in an attachment to my written testimony, the primary challenges NOAA faces in this area lie in interagency coordination of license reviews with the Department of Defense. Timely license approvals are a particular problem for new and innovative applications where the national security implications can be hard to assess. This process does not directly address NOAA's willingness to acquire commercial data for weather forecasting. Space-based data sources of value to weather forecasting, such as GPS radio occultation, have not, to my knowledge, raised national security or foreign policy concerns in the commercial licensing process.

3) What policies and procedures should NOAA put in place to better facilitate the acquisition and application of commercial data to improve operation weather forecasting?

NOAA should have the analytical ability, as part of its program and project management processes, to perform "build or buy" decisions on a case-by-case basis. There may be circumstances where a government owned and operated space system is the most cost-effective approach to securing particular kinds of data for sustaining and improving weather forecasts. Such data may have little commercial value outside of government users or its acquisition may be too risky for private capital funding. On the other hand, some types of data may be commercially available or potentially available and the government may be only one of several sources of demand. Given NOAA budget constraints and the importance of weather forecasts, NOAA should be willing to consider a diverse portfolio of data sources for meeting its mission needs. NOAA should not preclude or avoid the use of private data sources except for compelling reasons of national security or public safety – which should be rare and unusual occurrences.

4) What would be the best way to address NOAA's current open data policy?

In general, open data policies have served NOAA and global meteorological community well. Continued efforts are needed to ensure other governments make relevant data sets available on an open and non-discriminatory basis as NOAA does with data from its government systems. However, the United States should not encourage NOAA or foreign governments to operate their taxpayer-funded capabilities in competition with the private sector. If public funds are used to create a relevant data source, the first premise is that the data should be openly available. If private funds are used to create data, the assumption should be that private property rights would be respected. NOAA should not create government systems that compete with private providers and should utilize private data sources to the greatest extent practicable – again, as mentioned earlier, consistent with data-driven "build or buy" assessments.

The White House Office of Science and Technology Policy, in consultation with U.S. industry, and affected departments and agencies (e.g., NOAA, NASA, and the State Department) should consider proposals to update international guidelines and agreements, such as World Meteorological Organization Resolution 40. The purpose of such updates would be to promote greater innovation and cost reductions through use of market forces in providing data about the Earth's weather and environment. The United States should continue its past commitments to open sharing of scientific data from publically funded systems and seek reciprocal commitments from other WMO member states. However, it should not apply such commitments to private data providers. If NOAA believes it is in the public interest to make private data sources globally available, it must be willing to pay for the necessary data rights and demonstrate why this is the most cost-effective approach.

NOAA should be focused on sustaining and improving its information products (e.g., weather forecasts) and commercial data should be considered as part of that effort.

Responses by Mr. Scott Sternberg

VAISALA

Vaisala Responses to Hearing Questions for the Record

US House of Representatives

Committee on Science, Space and Technology: Subcommittee on Environment

Pertaining to the hearing conducted on May 20, 2015 entitled:

Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts

Submitted by: Scott J. Sternberg, President, Vaisala Inc.

Question #1

What Process does Vaisala use to ensure the lightning data meets NOAA quality standards and user needs for accuracy and reliability?

In summary, Vaisala validates the performance of the network through ground truth tests and modelling techniques. Vaisala sustains optimum performance through a high degree of built-in redundancy and through a process of constant performance monitoring.

Vaisala regularly works on validation studies to understand and describe the performance of its lightning detection technology, and we encourage and support 3rd party scientists to do detailed validation, the majority of which is peer reviewed. This commitment to rigorous, objective validation is reflected by the wide adoption of Vaisala's lightning data within the scientific community, and to date there are more than 1,000 academic papers that utilize data from the National Lightning Detection Network (NLDN).

The comparison against rocket triggered lightning is an excellent means of validating performance of a lightning detection network. Rocket triggered lightning provides the requisite "ground truth" for the performance of a network at that particular location. The test facility at Camp Blanding, Florida, offers this capability and Vaisala and others have used the facility to analyze the NLDN data. Most recently Mallick et al., 2014 (Performance characteristics of the NLDN for return strokes and pulses superimposed on steady currents, based on rocket-triggered lightning data acquired in Florida in 2004–2012, Journal of Geophysical Research: Atmospheres, Research Article 10.1002/2013JD021401) compared NLDN reports against triggered lightning for a period of 8 years. This validation approach provides an unambiguous reference dataset that can calibrate the location accuracy, cloud-to-ground lightning detection efficiency, and classification performance.

While this type of validation study provides good validation at a specific location, it does not address the performance of the network over the wider geographic area of the USA. To validate the performance of the NLDN in other areas of the country, scientists from Vaisala and elsewhere use data on lightning strikes to towers or wind turbines and comparisons against research grade Lightning Mapping Arrays (LMA).

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At the 2014 International Lightning Detection Conference, Cramer and Cummins used data from 22 towers spread over the central U.S. to validate NLDN performance, and Cummins et al. performed similar validation using wind turbines in Kansas. Video validation studies of NLDN performance in the central and southwestern U.S. have also been carried out by Biagi et al. and Fleenor et al. (Cramer, J.A. and Cummins, K.L., 2014: Evaluating location accuracy of lightning location networks using tall towers, 23rd International Lightning Detection Conf., Tucson, AZ.; and Cummins, K.L., Zhang, D., Quick, M.G., Garolera, A.C., Myers, J., 2014: Performance of the U.S. NLDN during the Kansas Windfarm 2012 and 2013 field programs, 23rd International Lightning Detection Conf., Tucson, AZ; Biagi, C.J., Cummins, K.L, Kehoe, K.E., Krider, E.P. 2007: National Lightning Detection Network (NLDN) performance in southern Arizona, Texas and Oklahoma in 2003-2004., J. Geophys. Res., vol. 112, doi:10.1029/2006JD007341 ; Fleenor, S.A., Biagi, C.J., Cummins, K.L., Krider, E.P., Shao, X-M., 2009: Characteristics of cloud-to-ground lightning in warm-season thunderstorms in the central Great Plains, Atmos. Res., vol. 91, pp. 333-352)

Comparisons of the NLDN against research grade Lightning Mapping Arrays (LMA), which are installed at several locations across the USA, provide useful insight and validation of cloud lightning detection performance. At this year's American Meteorological Society Annual General Meeting, in Phoenix, Murphy and Nag presented the variation in total flash detection efficiency performance across the network by comparison with LMAs in Kansas, Colorado and Oklahoma. (Murphy, M.J., Nag, A., 2015: Cloud Lightning Performance and Climatology of the U.S. Based on the Upgraded U.S. Lightning Detection Network, Seventh Conf. On Meteorological Applications of Lightning Data, Phoenix, AZ, U.S., Amer. Meteorol. Soc.)

NOAA's quality standards apply country-wide. Therefore, in addition to validation studies, Vaisala also uses a sophisticated modeling technique to produce network projections of performance across the USA. This is based on the configuration of the sensor network and takes account of geography and terrain and has been tested against Vaisala networks in other countries.

To ensure that the validated levels of performance are maintained continuously over the entire country, Vaisala has personnel and systems in place that continually monitor the health of each sensor and the health of the network, and leverages procedures to ensure speedy resolution of any problems, whether they are out in the field or data center- or communications-related. The systems in place monitor the entire network so that if any aspect of the network is out of tolerance it is immediately analyzed and rectified.

Finally, an important aspect in our ability to maintain performance is nested in both the design of the network and the technology deployed in the sensors. High levels of performance are backed up by a high level of redundancy. Further, intelligent sensor design allows for remote monitoring and, in certain cases, remote upgrade and repair.

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VAISALA

Question #2

Has NOAA ever changed the terms of your contracts in regards to the openness of data?

The procurement of lightning data followed, and continues to follow, the NOAA procurement process. In general, previous contract periods extended for 5 years with delivery orders being issued on an annual basis. Contractual terms pertaining to the redistribution of the data were, therefore, dictated by the contract terms and conditions existing at those times. It is worth noting that NOAA conducted an open comment forum pertaining to the published draft of the "Policy on Partnership in the Provisioning of Environmental Information" in 2004 (http://www.noaa.gov/partnershippolicy/). This policy was signed into effect on January 19th, 2006. Subsequent contracts issued for data were done so in accordance with this policy.

a. *When entering into contracts with NOAA, was there negotiation about the terms of your data? Please elaborate.*

Once again, the procurement of lightning data followed the NOAA procurement process. As such there were opportunities, in the form of Requests for Information (RFI) and other discussion forums, to stress the need for data redistribution restrictions. However, per the process, potential contractors are required to respond to a published Request for Proposal (RFP) which dictated not only the performance requirements of that being procured but also the terms and conditions required by the government. It is therefore at the discretion of the bidder whether they wish to either challenge or accept said terms as part of the competitive process.

Question #3

Do you believe your partnerships with NOAA can be used as a model for future weather observing systems?

Generally, environmental observations can have many uses in potentially many markets. The balance achieved between Vaisala and NOAA in the context of lightning data is a great example of the recognition by both parties that a commercial market for data needs to be protected. As such, it is believed that Vaisala's partnership with NOAA could serve as an excellent reference for future weather observing systems, including the situations associated with the provisioning of data to NOAA. By doing so, it is possible for both the government to obtain a cost effective data set while providing the private sector an opportunity to pursue commercial markets for the same raw data. More importantly, however, is how value is added to *raw data* to create *information*. The history of lightning data creation and provisioning has shown that as long as the missions across federal agencies and the value propositions between commercial markets are substantially different, then restricting the raw data redistribution by the federal agencies and allowing for competition and parallel development for actionable information is a recipe for the long term sustainability of the observing system.

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Responses by Ms. Nicole Robinson

HOSTED
PAYLOAD
ALLIANCE

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June 22, 2015

The Honorable Jim Bridenstine
United States House of Representatives
Committee on Science, Space, and Technology
Chairman, Subcommittee on Environment
2321 Rayburn House Office Building
Washington, DC 20151-6301

Dear Mr. Bridenstine:

Thank you for the opportunity to testify to the Committee on Science, Space, and Technology in a hearing entitled *Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts* on Wednesday, May 20, 2015.

Related to your subsequent question, "For decades, the U.S. has used hosted payloads for a variety of U.S. government missions. What do you see as the top benefits for expanding the use of hosted payloads across mission areas like weather?" I would like to offer the following response.

The idea of hosting government payloads on commercial satellites is nothing more than offering additional options for the government to have access to space. Since the commercial industry is utilizing proven and repeatable practices to acquire their space systems, the timelines from requirements development to on-orbit capability is drastically shorter than a normal government program. When near term capabilities are needed quickly to augment, supplement, complement, or replace other capabilities, commercial satellite acquisitions can often help meet those needs in a timely and cost effective manner.

Space-based weather capabilities are a prime example of a near term shortfall or capabilities gap that needs to be filled quickly to meet warfighter needs. Nearly 20 commercial geostationary satellites are launched each year and each represents another opportunity to benefit from a potential cost-sharing arrangement to place a weather sensing capability into orbit. On behalf of U.S. taxpayers, the government has a proven and responsive business case to leverage for a faster and more cost effective way to get government weather sensors and instruments to space.

If I may offer additional information to the Committee, please contact me by telephone at (703) 610-0972 or by email at nicole.robinson@ses-gs.com. I would be delighted to have an opportunity to discuss this further.

Sincerely,

Nicole Robinson

Nicole Robinson
Chair, Hosted Payload Alliance

Responses by Dr. Thomas Bogdan

Tom Bogdan's responses to follow-up questions following his May 20, 2105 Hill Testimony

Questions:

1) Using the satellite telecommunications, satellite imagery, and burgeoning space launch industries for reference; do you believe that commercial weather data have the potential to reduce NOAA's satellite program costs and help mitigate gaps in government assets.
2) Please discuss the various forms of data used for research purposes. Is any of the data used for research purposes under restricted data policies within NOAA, such as AMDAR or Lightning data?
3) Are there ways to provide access to atmospheric data to researchers while also fostering a commercial weather industry? Please describe examples of how this might look.

Answers:

1) The answer to the hearing question is a cautionary "yes." As the telecommunications, imagery, and launch industries have demonstrated, the viable commercial enterprises in space have grown and matured to the point where government can procure products and services at lower costs from commercial entities. However, in each of these cases, the United States government procured these services through traditional means in parallel to the commercial entities' development. Not until they were sufficiently mature and could demonstrate success (self-financed success), did the government begin to procure services from the satellite telecommunications, satellite imagery, and space launch industries. As such, it would be wise for NOAA to ensure that commercial data is dependable, maintains high efficacy and quality, and will be provided affordably before it begins to depend on these industries to reduce costs and mitigate gaps in government assets. With the need for government to provide free and open data exchange (following WMO resolution 40), the government may have to be the sole buyer of key data set and thus pay for global licenses. The net cost saving to the government may not be as large as advertised.
2) Practically all data provided by NOAA is utilized for research purposes. As a research mission progresses along the Technical Readiness Level curve, towards operational capacity, it becomes increasingly important to receive these data in real time, just as the operational community does. Thus, AMDAR and Lightning data, which are eventually provided to the research community on a delay, are valuable only up to a point – the delay inhibits research application developments. It is desirable for the government to make an effort to make these restricted data available in a timely manner. Some research projects such as special observational field campaigns would benefit from near real-time data access (latency of hours).
3) It is incumbent on the commercial weather industry to assess the potential future market (both within and outside the government) to determine if the development of atmospheric data sources whose feeds would then be available for sale are a worthwhile endeavor. We hope to work closely with the private sector to assist in the determination of the feasibility, demand, and eventual private applications that the new sources would provide, in exchange for partnership and free data use by the research community once

the product is mature. We hope that commercial-academic partnerships can hasten the development and entry to market of new data sources and can enable better and robust research; this virtuous cycle would benefit greater society as well as shareholders.

The most valuable uses of weather data for society are near real-time applications such as Numerical Weather Prediction (NWP) and alert warnings provided by the NWS. NWP forecasts currently benefit from weather data with latencies less than 3 hours, and in the future will require latencies of less than 1 hour as data assimilation update cycles become more frequent. NWS warnings such as high sea warnings would also only benefit from weather data with latencies of hours. One approach to provide access to atmospheric data to researchers while also fostering a commercial weather industry would be to make the weather data available free of charge 24 hours after observation, but charge for the near real-time data. This approach would benefit most research applications while providing a viable business model for commercial industry. As stated in the response to the first question, to encourage free and open data exchange, the government may have to be the sole buyer of the commercial weather data, and pay for global licenses for all users including researchers.

Appendix II

Additional Material for the Record

LETTERS SUBMITTED BY CHAIRMAN JIM BRIDENSTINE

GeoOptics

201 N. Orange Grove Blvd., Suite 503
Pasadena, CA 91103

The Honorable Jim Bridenstine
Chairman, Subcommittee on Environment
Committee on Science, Space and Technology
US House of Representatives
Washington, DC 20515

The Honorable Suzanne Bonamici
Ranking Member, Subcommittee on Environment
Committee on Science, Space and Technology
US House of Representatives
Washington, DC 20515

5/19/15

Dear Chairman Bridenstine and Ranking Member Bonamici:

Thank you for scheduling your upcoming hearing "Advancing Commercial Weather Data: Collaborative Efforts to Improve Forecasts," and for your work in passing H.R. 1561, the Weather Research and Forecasting Innovation Act.

Our national weather prediction enterprise is at a crossroads, and I am happy to know that the House Science Committee Subcommittee on Environment is facing that challenge head on. Gathering atmospheric data, modeling the atmosphere, and interpreting the results have all become more complex in the last few years, a trend that promises to continue in the future. The work you and the committee are undertaking will ensure that the National Oceanic and Atmospheric Administration (NOAA) has the appropriate policies and resources in place to thrive in this new environment.

GeoOptics is a leader in GPS radio occultation (GPS-RO) technology, which can measure the atmosphere in a way that is uniquely accurate and useful. The GeoOptics constellation will provide data that can see into the heart of the strongest storms and help predict their paths. The data will also be able to calibrate other satellite data, increasing the power of our existing weather resources. By leveraging the signals from the nation's GPS system and technologies present in every smartphone, GeoOptics satellites will be smaller and more affordable than traditional weather satellites, allowing our knowledge of the atmosphere to expand dramatically without stretching the budget.

I believe that accurate and timely knowledge of the weather is important to every American and is vital to our economy. We look forward to partnering with NOAA to continue the dramatic improvement it has made in our nation's weather forecasts. I applaud your leadership in pursuing legislation on these matters, and stand ready to provide any information you might need.

Sincerely,

CC Lautenbacher Jr.

Conrad C. Lautenbacher, Jr.
Vice Admiral, U.S. Navy (Ret.)
CEO, GeoOptics, Inc.

GeoOptics
201 N. Orange Grove Blvd., Suite 503
Pasadena, CA 91103

The Honorable Lamar Smith
Chairman, Committee on Science, Space and Technology
US House of Representatives
Washington, DC 20515

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space and Technology
US House of Representatives
Washington, DC 20515

5/18/15

Dear Chairman Smith and Ranking Member Johnson:

I write to thank you for marking up H.R. 1561, the Weather Research and Forecasting Innovation Act in the House Committee on Science, Space and Technology. It is heartening to see a bipartisan effort to address the important issues facing the national weather enterprise. GeoOptics is in strong support of bill and we support efforts to bring it before the full House of Representatives as soon as possible.

H.R. 1561 has a number of important provisions, including sections on improving observing system, computing and weather research planning, and improving severe weather predictions. I believe it is particularly important for NOAA to carefully evaluate its space-based observing systems to make sure it is creating its forecasts as efficiently and effectively as possible. GeoOptics is also a strong supporter of Section 10 of the bill, which clarifies existing law to encourage NOAA to pursue the purchase of commercial weather data.

GeoOptics is building a constellation of small satellites that will provide advanced, affordable and reliable weather and environmental data to the Federal government and other customers. The GeoOptics constellation will provide data that can see into the heart of the strongest storms and help predict their paths. The data will also be able to help calibrate other satellite data, increasing the power of our existing weather resources. By leveraging the signals from the nation's GPS system and technologies present in every smartphone, GeoOptics satellites will be smaller and more affordable than traditional weather satellites, allowing our knowledge of the atmosphere to expand dramatically without stretching the budget.

By including Section 10, you have taken a necessary step to ensure NOAA has the authority and encouragement of Congress to purchase high-quality weather data from commercial providers. I believe that commercial weather data can reinvigorate NOAA's data acquisition and put the agency on a strong path into the future.

I believe this broadly supported, bipartisan bill should be brought to the House Floor as soon as possible and I thank you both for your leadership on this important issue.

Sincerely,

CC Lautenbacher Jr.

Conrad C. Lautenbacher, Jr.
Vice Admiral, U.S. Navy (Ret.)
CEO, GeoOptics, Inc.

PLANETIQ

CRITICAL DATA FOR A SMARTER PLANET

The Honorable Lamar Smith
Chairman
Committee on Science, Space and Technology
2321 Rayburn House Office Building
United States House of Representatives
Washington, D.C. 20515

The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space and Technology
2468 Rayburn Office Building
United States House of Representatives
Washington, D.C. 20515

Dear Chairman Smith and Ranking Member Johnson:

I am writing to congratulate you on the bipartisan effort that has brought about the rapid introduction and approval by your Committee of the critically important Weather Research and Forecasting Innovation Act. I want to implore you to continue to work for passage in the full House of Representatives and to ensure that disparate interests in the Senate not dilute this strong and effective legislation. As I'm sure you are aware, the legislation in this Act is critical to the safety of Americans, the well-being of businesses nationwide, and the overall stability of the U.S. economy. Passage of this Act is also critically important to the future of the U. S. space industry.

Catastrophic weather has become ever-present in the news and, indeed, across our land. From Hurricane Katrina and Superstorm Sandy to the violent EF4 and EF5 tornados that ravage parts of our heartland year after year, all with a backdrop of floods and droughts that are breaking historical records, our nation is faced with a growing threat to our people and our economy. Meanwhile, our nation's forecasting capabilities, already behind those of the Europeans, are on the verge of regressing even more just when we need them to get better. This is largely due to a decline in U.S. weather satellite coverage that is already underway and expected to get much worse, as well as an overall lack of resources devoted to weather forecasting activities.

Your committee has done a superb job of crafting legislation that places appropriate emphasis and resources on developing observational, computing and modeling capabilities that will deliver required improvements in weather forecasting, especially in prediction of extreme events that pose the biggest risks to life and property. At a time when partisan issues have mired much of our nation's priority legislative initiatives, the Environmental Subcommittee has developed legislation that all can agree will best serve our nation and better protect our people and infrastructure.

Importantly, this legislation recognizes and nurtures the role of private industry in data collection and weather forecasting. U.S. companies stand ready to augment our national observing systems in a way that strengthens the global observing system, accelerates innovation in data collection, lowers government costs and creates high-tech U.S. jobs. The engagement of private industry encouraged by this Act is crucial to maintaining and improving the accuracy of weather forecasts in the years and decades to come, and to establishing U.S. leadership in a new race to space, while more evenly spreading the costs of data collection among stakeholders worldwide, rather than saddling the U.S. taxpayer with the lion's share of the financial burden.

Passage of the Weather Research and Forecasting Innovation Act is imperative to our nation's safety and security, and will help better position the U.S. space industry to compete at home and abroad. I encourage you to continue to push for passage in the full House of Representatives and to stand firm for its key provisions in conference with the Senate. If you have any questions regarding our support for this initiative, please do not hesitate to contact me directly at 240-285-1584, or by e-mail at amiglarese@planetiq.com.

Sincerely,

Anne Hale Miglarese

Anne Hale Miglarese
President & CEO

7315 Wisconsin Ave, Suite 400 West
Bethesda, MD 20814

www.PlanetiQ.com

spire

05/15/2015

The Honorable Lamar Smith
Chairman
Committee on Science, Space, and Technology
U.S,. House of Representatives
2321 Rayburn House Office Building
Washington, DC 20515

The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
U.S,. House of Representatives
394 Ford House Office Building
Washington, DC 20515

Dear Chairman Smith and Ranking Member Johnson:

Regarding: Letter of support for H.R. 1561 – The Weather Research and Forecasting Innovation Act of 2015

First and foremost, I would like to thank you for your commitment and continued support of the advancement of Science, Space and Technology in the United States. The progress you have made with H.R. 1561 – The Weather Research and Forecasting Innovation Act of 2015 is astounding and, if passed, will prove to be a tremendous value to the businesses, development and safety of the United States. To improve the National Oceanic and Atmospheric Administration's weather research through a thoughtful, cost effective, focused program that incorporates partnerships with private organizations is an idea that is widespread for optimizing weather forecasting - not only in the U.S., but globally.

Most private companies cannot compete with the capabilities of NOAA, but can partner with them and provide data that is valuable to them and their value added systems. As you know, in the U.S. we have a looming weather data gap, but thankfully, as outlined in H.R. 1561, there are promising ways to close the gap. Data provided by GPS-RO, private companies, private-public collaborations are promising solutions. To operate in a collaborative spirit on combined technology takes the best of both worlds and provides a better service to the users of that technology and data.

With the private and public sectors working together, we will be able to move last century's weather forecasting into the 21st century - where weather is as predictable as it should be. We live with unpredictable weather and everyone accepts it as a part of everyday life. We know, however, that it is just a lack of data, not technology. We simply do not have the right amount of sensors and data information that we need to make better weather predictions. This data coupled with the weather models that we currently use will dramatically improve weather forecasting.

The weather impact on various industries in the U.S. is close to 5 billion dollars. Weather touches every industry in the United States and the impact of not knowing the weather is profound. It is critical for the advancement, wellbeing and economy of the United States to pass H.R. 1561 – The Weather Research and Forecasting Innovation Act of 2015. It will set a new standard for ensuring that weather data is reliable, accurate and cost effective - substantially improving the lives of every American. If you have any questions regarding my or Spire Global's support for this initiative, please contact me directly at: 646-515-3375 or via e-mail: peter@spire.com. Thank you for your time.

Regards,

Peter Platzer
Chief Executive Officer
Spire Global, Inc.
415-356-3400

TEMPUS
GLOBAL DATA

May 15, 2015

The Honorable Lamar Smith, Chairman
The Honorable Eddie Bernice Johnson, Ranking Member
Committee on Science, Space and Technology
US House of Representatives
Washington, DC 20515

Dear Representatives Smith and Johnson:

Tempus Global Data supports the passage of HR 1561, the Weather Forecast and Innovations Act of 2015. Tempus has nothing but praise for those members of the Committee on Science, Space and Technology that forged a bi-partisan coalition and worked together to advance this critical legislation. We want to thank Representatives Smith, Johnson, Bonamici, Bridenstine, Lucas, Rohrabacher and to Chris Stewart for his early leadership on this bill.

This bipartisan bill will help improve America's severe weather forecasting capabilities through a visionary weather research plan at the National Oceanic and Atmospheric Administration (NOAA). We applaud your forward thinking to require the Commerce secretary to draft a strategy to enable the procurement of commercial weather data. By creating the Commercial Weather Data Pilot Program this will enable NOAA to better consider private sector data that will be more cost sustainable and also, help save lives.

Tempus is an atmospheric and environmental data company, headquartered in Ogden, Utah, has licensed hyperspectral atmospheric sounding technology from Utah State University that will provide highly complex views of the atmosphere in three dimensions. We are planning to launch a constellation of sensors in a geosynchronus orbit. Our STORM sensors will capture persistent and recurring slices of the atmosphere, which result in unprecedented accuracy and clarity to provide forecasters with better data to enable them to make more accurate weather predictions. Big data sets and visualization tools will inform and drive critical business decision-making for economic sectors.

We concur that HR 1561, the Weather Forecast and Innovations Act of 2015, is the first step towards giving NOAA the authority to purchase high-value commercial weather data and will help NOAA regain its global forecasting superiority in weather prediction.

Sincerely,

Alan Hall, Chairman and CEO

Panasonic

May 15, 2015

The Honorable Lamar Smith, Chairman
The Honorable Eddie Bernice Johnson, Ranking Member
Committee on Science, Space and Technology
US House of Representatives
Washington, DC 20515

Dear Representatives Smith and Johnson:

Panasonic Avionics Corporation supports the passage of HR 1561, the Weather Forecast and Innovations Act of 2015. Panasonic Avionics has nothing but praise for those members of the Committee on Science, Space and Technology that forged a bi-partisan coalition and worked together to advance this critical legislation. We want to thank Representatives Smith, Johnson, Bonamici, Bridenstine, Lucas, Rohrabacher and Stewart for their leadership on this bill.

This bipartisan bill will help improve America's weather forecasting capabilities through a visionary weather research and implementation plan at the National Oceanic and Atmospheric Administration (NOAA). We applaud your forward thinking to require the Commerce secretary to draft a strategy to enable the procurement of commercial weather data. By creating the Commercial Weather Data Pilot Program this will enable NOAA to better consider private sector data that will be more cost sustainable and also, help save lives.

Panasonic Avionics Corporation's core weather technology includes:

- Its Tropospheric Airborne Meteorological Data Reporting (TAMDAR) sensor, a small and lightweight device designed to collect sophisticated weather data from the atmosphere during the flight of an aircraft. TAMDAR is installed across a network of hundreds of commercial aircraft that are operated by more than a dozen partner airlines. It collects thousands of highly detailed and accurate readings from the upper atmosphere each day.

- The ability to transmit the atmospheric data over Panasonic's global aeronautical networks, including Iridium, in real time to the Panasonic operations center

- Its scientific and engineering teams' solutions to analyze and quality control and assimilate the atmospheric data to ensure accuracy, providing the maximum benefit for weather forecasting models.

We concur that HR 1561, the Weather Forecast and Innovations Act of 2015, is the first step towards giving NOAA the authority to purchase high-value commercial weather data and will help NOAA regain its global forecasting superiority in weather prediction.

Sincerely,

Neil Jacobs
Chief Atmospheric Scientist
Panasonic Avionics Corporation

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